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THE NORTHERN HIGHWAY OF PERU

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IT is sometimes difficult for even travelled Europeans, unacquainted with the Southern Continent, to realize the enormous size of the three largest republics of South America. Brazil with its 3,300,000 square miles of territory has an area larger than the United States, Argentina has approximately 1,080,000 square miles, while Peru, only a little larger than Colombia since the settlement of the boundary dispute with Ecuador in 1942, is estimated to cover now some 500,000 square miles of territory, approximately five times the size of Spain.

With the Andes separating Peru's eastern provinces from the Pacific coastal region, regular contact between the Capital and Amazonia was, until eight or ten years ago, almost nil. In fact, after the opening of the Panama Canal in 1914, a normal route for a native of means living at Yurimaguas on the Huallaga river, who wished to visit Lima, was to travel by boat some 2000 miles down the Amazon to Belém (Pará) and go thence by steamer up the Atlantic coast through the Canal and down the Pacific coast to Callao, or even to travel via Liverpool rather than face the risks and hardships of that execrable trail known as the Via del Norte or the Northern Highway.

The great development during recent years of President Leguia's wise road-building policy and the construction of aviation grounds, not only on the coast and near populated centres, but also on the banks of rivers in the heart of the forest country, have already had the effect of linking up places, sometimes in point of distance relatively near, though actually hitherto almost inaccessible to each other.

When visualizing a journey from Lima, or any other town, on the Peruvian coast to any part of the Amazonian provinces, it is important always to bear in mind the country's three main, sharply contrasted geographical divisions. First the narrow coastal desert, a zone which runs for some 2300 miles down the Pacific coast approximately from lat. 4° S., near the important oilfield of Talara, to lat. 33° S., a little north of Valparaiso; secondly the zone of the

great Cordilleras, which culminate in Peru in that snow-clad giant, the Huascarán, 22,205 feet high, Peru's highest mountain, climbed once only, in 1932, by a German scientific expedition; and thirdly the vast, uncharted forest region, known as the Montaña, through which great rivers like the Ucayali, Purus, Napo, and Madre de Dios, worm a sinuous course to the Amazon.

All the great rivers of Peru's Amazonian watershed have, in their lower courses, a strong resemblance: mile after mile of dirty slow-flowing water, the surface ruffled by little eddies and whirlpools; the dense forest in which a single square mile might yield a hundred species of trees, pressing to the river's margin; crumbling mud banks with forest giants lying prostrate where they crashed into the river at flood-time, and frequent islands, some in the process of formation, others of disintegration, many of them large enough to make it impossible for a traveller unfamiliar with a river to guess which side is the branch and which the parent stream. On these rivers the navigation channel is rarely in mid-stream, but usually near the bank, so that the impression is often less of being on a river than of skirting the shore of a lake, an illusion which is frequently fostered by the river appearing to open out into a large bay, in reality the confluence of an important tributary.

The Peruvian rivers of the Pacific watershed, on the other hand, present an entirely different picture, all having the characteristics of mountain rivers, raging torrents during the rains and in the dry season little more than insignificant streams, usually broken up into many small channels in a wide, stony bed. Owing to the extensive tapping of the waters of these rivers for irrigation purposes, some of them hardly succeed in reaching the ocean even during the rains. For this reason anadromous fish are not found in their waters. In fact, owing to the proximity of the Andes to the coast, it is correct to state that, with the exception of the Guayas, nearly 2 miles wide at its mouth and navigable for nearly 80 miles above Guayaquil, the whole 4000 miles of the Pacific coast of the Southern Continent does not boast a single river which could be described as navigable for even small steamships. Ecuador's Esmeraldas is only an important fluvial system, for many of its rivers have so swift a current that they can be navigated by canoes only, and by them with difficulty. The many waterways of southern Chile are only estuaries, canals, and sheltered straits.

The division of Peru into three regions only is perhaps a little arbitrary and over-simplified, for whereas the western foothills of the Andes at 6000 feet have, except for the ephemeral Lomas vegetation of the winter months, little plant-life but cacti and xerophytic scrub, on the Atlantic side at the same elevation the Amazonian forest has only just begun to thin out and the mountain sides are still covered with luxuriant growth. As the Andes must always be thought of as two, often three, roughly parallel chains, it is obvious that in their deep valleys many variations of climate and vegetation will be found, until, after descending the foothills of the last eastern range, the relative uniformity of Amazonia is reached.

Yurimaguas, on the left bank of the lower Huallaga, can be considered to be either the beginning or the end of the Northern Highway, for once there Iquitos can be reached by steamboat, whence thousands of miles of the

Huascarán from Yungay, the Santa valley

Valley of the Huallaga below Huánuco

A street in Huánuco

azon and its tributaries are open to the traveller. In order to reach imaguas there were in 1938 three possible routes from Lima, not counting one by sea journey to Belém and thence up the Amazon. First the northern nway of Cajamarca, Chachapoyas, and Moyobamba; secondly the well-wn Pichis trail from Tarma and La Merced to the Pachitea and Ucayali rs; and thirdly by raft or canoe down the Huallaga from Tingo Maria. e completion in 1943 of the new highway from Lima to Pucallpa on the er Ucayali now offers another alternative route during the dry season, ghly from June to October. I hesitate to describe this way over as a fourth te, because an air service from San Ramon now carries the mail, which d to be sent by mule train, with the result that the Pichis trail, which had e kept open when in regular use, is now being gradually abandoned and everting to trackless forest.

Two interesting South American travel books were published by the firm of n Murray, one in 1829, the other in 1831. The first, written by Lieutenant w of His Majesty's Navy, describes a journey by the Northern Highway m Trujillo to Yurimaguas and thence down the lower Huallaga and Amazon Belém; the second one, written by two naval officers, Lieutenant Smyth d Mr. Lowe, describes the route from Lima to the Huallaga river by Cerro Pasco and Huánuco, the descent of that river to Yurimaguas and thence to Amazon's mouth. After reading these two books, I decided to combine at appeared to me to be the more interesting halves of the two journeys, the scent of the Huallaga by raft to Yurimaguas and a return journey thence to Pacific coast by the Northern Highway.

I left Lima for Huánuco by camionette the third week of June 1938, when dry winter months make it probable that rivers will be in good condition travel. From the beginning of May until the end of October very little n falls in the Cordilleras. The rainfall is usually heaviest in December, nuary, and February; but the traveller must always be prepared for the sibility of heavy rain in the Montaña in any month.

Huánuco can be reached by two routes from Lima, the Central railway or d up the Rimac valley to Oroya and Cerro de Pasco or by road to Canta the valley of the Chillon over the Viuda pass, 15,256 feet high, to Cerro de sco, about 1000 feet lower than the top of the pass. The former route is ays interesting, for the Central railway is the highest standard gauge rail-y in the world, reaching an elevation of a little over 16,000 feet, and passing rough magnificent mountain scenery. But I had travelled more than once the Central railway, so I chose the other route, spending the first night at little Sierra town of Canta, built on the inevitable Spanish Colonial plan of quare plaza showing the usual features of a church, the municipality, and barracks of the Civil Guards. Here we were rebuked by Authority and fered to reverse the position of our lorry, which had halted in the plaza inting in a direction contrary to traffic regulations, the only traffic at that ment being a grave-looking Serrano in a high straw hat and cinnamon-oured poncho, mounted on a small donkey, and a cow with a knife-edged k. The following evening saw us at Huánuco after a laborious run of rteen hours over a splendidly engineered road, though at that time with a

surface better adapted for travel by mule than by motor vehicle. The surface was vastly better when I went over the same road in the reverse direction in November 1942 on the last day of a five-months' trans-Continental journey from Rio to Lima, but the fact that tyre shortage had reduced motor traffic to a minimum may be the explanation of the improvement.

The Cerro de Pasco plateau, which has been so often described owing to the interest of its tremendously rich silver mines, is a bleak, dreary, treeless upland, dotted with small shallow lakes and patches of marshy soil. It has a maximum width of some 40 miles and forms the divide between the Huallaga river system to the north and the Mantaro to the south. In spite of an unfulfilled wish to reach Huánuco before nightfall, I stopped to collect a few specimens of characteristic alpines, including gentians, nototriches, several dwarf composites squatting on the short turf, and a charming little prostrate, blue-flowered lupin. Although many of these flowers are of great botanical interest, they are not to be compared in beauty with the floral display of the Swiss Alps.

The town of Huánuco was founded by Pizarro in 1539, only four years after the foundation of Lima, some 40 miles from the old Indian town of Guánucu, on the Huallaga's left bank at the ideal elevation of 6270 feet above sea-level. The river, which here has all the characteristics of a mountain torrent, is some 35 yards wide, not more than 3 feet deep in its channels during the dry season, and constantly broken with little rapids.

An officer of the United States Navy, Lieutenant Herndon, who travelled to Huánuco in 1851, wrote an interesting and well-known book, 'Exploration of the valley of the Amazon,' in which he stated that the inhabitants of the place appeared, even then, to be convinced that the economic future of Peru depended upon the building of roads to link up her Andean provinces with the navigable rivers of Amazonia. To quote his own words: "People in Huánuco are fully alive to the importance of opening the navigation of the Huallaga to their city." Were they living to-day they would see their dream fulfilled, though not by navigating the Huallaga, which is always a dangerous and at some seasons an almost impossible river even for rafts, but by the opening of the new highway to Pucallpa on the Lower Ucayali, for which Huánuco is the jumping-off point.

The valley of Huánuco is some 15 miles long and 3 miles wide. The main town, which, with its outcrop of villages, has a population of approximately 25,000 inhabitants, is the centre of a prosperous agricultural region. A modern hotel has recently been built there in the attractive Spanish Colonial style, and the town is an ideal stopping place to enable travellers coming up from the Montaña, who are subject to mountain-sickness, to acclimatize themselves to moderate elevation before crossing the high passes to reach the Pacific coast.

The Carpish divide, on the road to Tingo Maria, is a floral paradise for botanists and was a favourite collecting-ground of those two famous Spanish botanists, Ruiz and Pavon, and their French colleague, Dombey.

The new highway to the Montaña follows the right bank of the Huallaga and some 15 miles out of Huánuco crosses to the left bank, leaving the river where it makes a big easterly bend, and goes up the slope of the Carpish

divide. Here the vegetation changes abruptly from the semi-xerophytic types of the Huánuco valley to tree-ferns, giant equisita, fuchsias, bomareas, melastomads, and other typical rain-forest forms, which trickle for some distance down even the western side of the divide. The divide is crossed at an elevation of 9250 feet, nearly 3000 feet higher than Huánuco, and the traveller, following the right bank of the Chinchao high up on the side of its valley, finds himself with dramatic suddenness on the threshold of Amazonia.

On the relatively few days when the view is not obscured by mist or driving rain, a conspicuous feature of the landscape is the bright green plantations of the Coca shrub, cultivated on the lower slopes of the Chinchao valley. Much has been written on the subject of the Divine Plant of the Incas, almost too much, for W. G. Mortimer's 'History of Coca' contains a bibliography of some six hundred volumes and pamphlets, expressing much diversity of opinion about the effects of chewing the coca leaf. I have seen many Indians, addicted to the habit, of an obviously drugged and degenerate appearance; but I have also travelled with muleteers, who habitually had recourse to the comfort of the Divine Plant, and were alert, intelligent, and of more than average physique. Apart from excess, it may be that just as different types of wines are the products of different soils and climates, so leaves of plants grown in certain districts have a higher cocaine content and are poorer in associated sweet and aromatic alkaloids, which might explain their different effects on the nervous system, for it must be remembered that, although cocaine is the chief alkaloid contained in the coca leaf, it is no more representative of the whole than prussic acid of a peach. Attempts on the part of the Spaniards in early Colonial days to deprive the Indians of their coca leaves had to be abandoned, because without their accustomed stimulant they were incapable of the heavy tasks exacted from them, especially of the vital one of working mines at high altitudes. The chains of running messengers, who conveyed news by word of mouth from one part of the Inca Empire to another, depended absolutely on the coca leaf to enable them to perform their prodigious feats of endurance in the high Cordilleras. In Colonial days coca leaves were a common medium of exchange, which is still used in remote districts.

The road down the Chinchao valley to Tingo Maria is still frequently blocked by landslides during the rainy season. The first time I travelled over it, as late as the last week of June, 50 yards of highway at a tricky bend had fallen into the valley below.

Tingo Maria, on the Huallaga's right bank, is one of the Peruvian Government's most cherished colonizing schemes. At present it is the only settlement of any importance between Huánuco and Pucallpa, the terminus of the highway on the Lower Ucayali. Including the surrounding farms up and down the valley, nearly all of recent development, Tingo Maria has a population of over 4000 souls. Sugar-cane, maize, yuca, citrus fruits, and barbasco[1] are the main crops. Tea plantations have also been established, though the lower elevations of the region are less adapted for tea-growing than the Santa Maria district of the Urubamba valley; but the high ground on the Huánuco side of the Carpish divide produces tea of a very high quality, in fact the Pati

[1] *Lonchocampus Nicou*, one of the sources of the insecticide roterione.

tea from this region is the best grown in Peru. Inexpert picking is one of the great difficulties which handicap Peruvian tea-planters in their efforts to grow a high-class tea. But, as the harvesting of the coca leaf also demands expert picking, there would appear to be no reason why a race so gifted for agriculture as the natives of Peru should not learn quickly and become equally expert on tea plantations.

The journey down the Huallaga I have described in detail in my book 'A forgotten river,' so I will not do more than touch upon the more interesting moments of a three-weeks' journey by raft from Tingo Maria to Yurimaguas, the gateway to the Northern Highway.

The Huallaga, from its source near Cerro de Pasco to Huánuco, drops almost exactly 8000 feet, between Huánuco and Tingo Maria some 4000 feet, and another 1600 feet between Tingo Maria and Yurimaguas. We used three rafts for the journey, the first of which was 24 feet long and 12 feet broad, built of seventeen poles of the light porous wood of *Ochroma Lagopus*,[1] locally known as the Balsa, or raft tree. The poles are lashed together with lianas from the forest, which are tougher and more suited to the purpose than any rope. The poles at the stern are left of irregular shape and length in order better to withstand the shock of probable collisions with snags or rocks. In the middle of a raft a platform is built of bamboos, 2½–3 feet above the river's level, where baggage can be stowed and passengers sit. Our third raft was almost a state barge, being composed of twenty-four poles, and having a thatch of palm fronds to shelter the platform and an extension from its stern end, upon which a thick layer of earth piled on a heap of banana leaves made an excellent foundation for our kitchen fire. On a small raft, the *Bogas*, as the raftsmen are called, sit on the front, their legs often dangling in the water, piloting their crazy craft with rather heavy paddles about 4 feet long. The larger rafts are propelled forward by long sweeps resting on tripods. The navigable channel shifts from bank to bank, and instinct as well as familiarity with a river is a good half of a raftsman's equipment, in order to avoid crashing into submerged rocks, attempting too shallow places, and being able to calculate just how far a raft should be propelled across a river in order that the current may swing it clear of obstacles ahead.

Of the Huallaga's many rapids the always formidable ones are the Cayumba above Juanjui and the 5 miles of the Pongo de Estero below Shapaja. Of these the Cayumba (not to be confused with a left-bank affluent of the Huallaga of the same name) is much the more dangerous because the river drops considerably in a short distance, and the only channel where a raft can pass without a certainty of overturning is very narrow. Many lives have been lost here. The main difficulty of the Estero rapids, even when the river is in good condition, is their whirlpools. The raft of a Yurimaguas trader, a day or two after we descended the river, got drawn into one of the more formidable of them and revolved in it for three hours before they could extricate themselves. When the river is in flood these rapids are often almost, and sometimes quite, impassable. The great botanist, Richard Spruce, who went this way in 1857, describes how his canoe was nearly swallowed up in a whirlpool

[1] Some botanists consider that the Andean plant *O. boliviana* is distinct from *O. Lagopus* of the West Indies.—ED. *G.J.*

Road on eastern side of Andes, about 8000 feet

Bridge on the Pucallpa highway near Tingo Maria

The third raft on the Huallaga

Raft near riverside settlement on the Huallaga

nd how a favourite dog went mad from fright. These whirlpools, *pongos* as ey are called, can be a very real peril when a river is in flood. One of the ost redoubtable of them is the famous Pongo de Manseriche, where the mazon (here still the Marañon) breaks through the last foothills of the Andes etween the mouth of the auriferous Santiago river and the little settlement of orja. Here the river narrows at one point to a width of less than 60 yards ith a current of 10 miles an hour. It is interesting to recollect that the dis-nce by water from Borja to the Atlantic is some 2600 miles and that in its ng journey across the continent the Amazon from that point only drops bout 500 feet.

The banks of the Huallaga are very thinly populated and, except for three ights at the port of Uchisa and four at Juanjui, we spent every night either nder *tambos*, a thatched roof open on every side, supported by strong poles, r under improvised shelters built by the raftsmen, made out of cross-poles, ound to large tripods by lianas, and thatched with *caña brava* (*Gynerium agittatum*) and banana leaves. Beneath the shelter there was just room for amp beds and mosquito nets, without the protection of which one cannot leep beside this river, less on account of mosquitos than of vampire bats. These pests not only attack men, but also horses, mules, and even chickens, which usually die after being bitten on the head or neck. The blood-sucking bat is a very small species with a body only 3 inches long, whereas *Vampyrus pectrum* with a wing-spread of 30 inches is a fruitarian.

From Juanjui I rode to Saposoa, the provincial capital, about 20 miles way to the north-west, over a lovely switchback forest trail, along which the Tagua palm (*Phytelephas macrocarpa*) grows in profusion. This is the palm, well named by the Spaniards *Palma del Marfil*, meaning Ivory Palm, from which vegetable ivory is produced. The nuts are about the size of a large green walnut and are borne in the axes of the lower leaves of the pistillate palm in spathes the size of a man's head. A spathe can weigh as much as 30 lb.

Saposoa lies in an open valley on the left bank of the Sapo, which has to be forded in order to reach the town, and is surrounded by high hills covered with dense forest. Were the place not so difficult of access I should much like to return there and make it a centre for collecting botanical specimens; but the trail from Juanjui over which we rode is almost the only way of approach to this most isolated place, for most of the country to the north-west, west, and south-west, roughly the forest country between the Huallaga and the Marañon, is almost unknown, and a trail would have to be blazed the whole way from Saposoa to reach, for instance, the mines of Parcoy. The new high-way to Pucallpa, completed in 1943, is useless for reaching Saposoa unless a trail from it were cut to reach the Huallaga's right bank near the confluence of the Sapo or between the Cayumba rapids and Juanjui.

There are still two schools of thought among the road engineers about the Pucallpa highway. Many of them still say that after Tingo Maria the road should roughly have followed the right bank of the Huallaga to Yurimaguas instead of going north-east to the Aguaytia river and Pucallpa. The reasons they advance are that no large and costly bridges would have been necessary because after crossing the Tulumayo, all the Huallaga's affluents of any size are left-bank tributaries, whereas the present route, in addition to bridges

across the San Alejandro and Neshua rivers, will involve the building of one of the largest bridges, if not the largest, in South America, the one by which the highway will cross the Aguaytia river. Had the road followed the right bank of the Huallaga, Yurimaguas, which would then have been the terminus of the highway, is only forty-eight hours by small steamer from Iquitos against the week which, with stops for loading and discharging cargo, the journey takes from Pucallpa. Other advantages would have been that the Huallaga route, unlike the present highway, would have provided ample stone for road making, and no part of it would have been as costly and difficult to build as the 3 miles of the stretch known as the Boqueron de Padre Abad. This stretch did not come into the original survey of the highway, which was planned to cross the Cordillera Azul at some 8000 feet, a difficult and costly undertaking. There was a tradition of a river forcing its way by a break through down to the swampy Pampa del Sacramento and the then Head of the Roads and Railways, Don Federico Basarde, was convinced through reading an account of a journey made in the middle of the eighteenth century by the Franciscan Fray Alonso Abad, that he could not have reached the Pampa in the short time his journey took, had he travelled by a high pass over the Cordillera. As a result of intensive and difficult surveying of the country where the break through of a river was suspected, the gorge of the Yuracyacu river was discovered, which, although some 6500 feet deep, has a floor only 1500 feet above sea-level. A magnificent piece of road-building through this gorge instead of across the Cordillera saved the Peruvian Government the equivalent of nearly a quarter of a million sterling.

The town of Yurimaguas, which we reached almost exactly three weeks after embarking at Tingo Maria, was founded by Spanish missionaries in 1709, the nucleus of the original population being remnants of the Yurimaguas Indians, who migrated from the Amazon valley in order to escape from Portuguese slave-traders. It is built on the usual Spanish Colonial plan on the river's left bank. Until 1940 no census had been taken for sixty-four years, but the population of the town and its surroundings in 1938 was estimated at some four thousand souls of which probably 60 per cent. would have described themselves as white. It is extremely difficult to estimate correctly the numbers of the white population of Peru, for whereas in the 1876 census the white and half-caste population were divided into two categories, in the 1940 and 1942 censuses they were grouped together. The Huallaga here is over 200 yards wide with all the characteristics of a typical Amazonian river. The main channel during the rains is over 40 feet deep, and at no time of the year does navigation for small steamers between Yurimaguas and Iquitos present any difficulty.

After spending four days at Yurimaguas we left for Balsapuerto by the Paranápura and Cachiyacu rivers. The Paranápura is a left-bank affluent of the Huallaga and is navigable for canoes only. We travelled in two dugouts, each one poled by four Indians. Although the canoes were large and fairly roomy, one would have been insufficient for ourselves, camping equipment, boxes of botanical specimens and drying papers, and necessary stores.

The paucity of wild animals in South America, compared with Africa, and

the dense forests which shelter them add greatly to the difficulties of travel off the beaten track in Amazonia. Adequate food supplies must be taken on every expedition because it is impossible to depend upon game for the larder. Only six clearly defined species of deer have been reported from the whole of South America, three of which are natives of Peru, and no gazelles or antelopes against the seventy species which are found in Africa.

The river was very shallow after three weeks without rain, and our canoes constantly scraped the bottom of the sandy river-bed. In many places enormous snags, which almost blocked the river, allowed barely sufficient room for a large canoe to pass and demanded constant vigilance from our Indian crews. Now and then large sand-banks almost barred the way. On some of these the keen sight of the Indians detected the tracks of turtles and they landed to search for their eggs. But it was still too early in the season and the creatures had apparently only been prospecting for desirable sites for their nurseries. The Indians say that a turtle returns each year to the same spot to make her nest. More probably, I think, the same spot continues to be a satisfactory site for a nesting turtle. Their eggs, which have flexible, leathery shells and oily yolks, are acceptable in the absence of hens' eggs, and the creatures themselves make excellent soup. The turtle-soup of commerce is made from a marine species which, unlike its freshwater relative, is almost exclusively herbivorous.

The course of the Paranápura is a never-ending enchantment, each bend revealing a lovely vista. The forest is much less dense and forbidding than the impenetrable tropical growth on the Huallaga's banks. In many places clearings and small settlements have allowed isolated trees to grow into magnificent specimens, which combined with slopes covered with coarse grass, give from a distance an almost park-like effect. Birds too were more frequent or perhaps more easily observed than on the Huallaga. Conspicuous among them were flights of vivid emerald green parakeets, large black and white toucans, terns, dippers, a rather familiar kingfisher with a brownish-red breast, now and then macaws flying in pairs, and stately herons. A lovely little manakin, with one-half of its body dark brown, the other half white, and a brilliant scarlet head, was also common.

After three days we left the Paranápura and ascended a right-bank affluent, the Cachiyacu, which means in Quichua the salt-river (so-called from salt deposits on its banks), and two days later arrived in the late afternoon at Balsapuerto.

Balsapuerto is a little Indian and half-caste settlement of some three hundred inhabitants, situated on a high bluff on the Cachiyacu's left bank. It was probably a more populous centre in the seventeenth and eighteenth centuries, just as the banks of the Amazon were more thickly inhabited then than to-day. That great Jesuit missionary and explorer, Father Samuel Fritz, writing about 1700, states that there were no less than forty-one Indian settlements in his reduction alone. To-day most of these have disappeared and of others only a few huts remain to mark their sites. The term reduction, as used by the Jesuit Fathers in South America, strictly meant reduced from savagery to civilization, and had no religious significance. Actually it was applied to districts administered by the Jesuits where they had converted and baptized the Indians.

Balsapuerto itself is just an Indian village on the fringe of the forest. Th houses are all bungalows built of thatch and bamboo each side of a bro grass street. It boasts a church with a wooden spire and a general store; th padre's house alone has a tiled roof. On our arrival after a brief and friend discussion with a local magnate we found ourselves the tenants of a thre roomed bungalow built of split bamboos with mud floors and a small backya with a shed for cooking. It was not exactly labour saving, but as the rent w only 2*d* a day it would have been churlish to complain.

Moyobamba, the next stage of the Northern Highway, is a week's strenuo march from Balsapuerto. The journey can be done on foot only, for as th trail is too difficult even for mules, all baggage has to be carried on the bac of Indians. This bit of country, the last foothills of the Eastern Cordillera is a complicated network of rivers and streams, cutting their way throug steep, densely wooded valleys, and is the most arduous stretch of the Norther Highway. Streams and rivers of varying size have to be forded sixty to seven times during the week's march to Moyobamba. The new road from th coast, which will more or less follow the ancient trail, will avoid the majo difficulties of this region by descending the valley of the Mayo to Tarapot and swinging thence in a northerly direction to Yurimaguas. To follow th Mayo downstream to the Huallaga would be useless, because Shapaja, nea its mouth, is above the Estero rapids.

The Indians of the Balsapuerto region are mostly of a markedly Mongo type. Their coarse black hair is cut low on the forehead in a straight fring like a Japanese doll and they paint their faces in geometrical patterns wit dark purple or reddish-brown vegetable dyes. They are not above using a indelible pencil from the village store for the purpose. Their endurance i remarkable and they carry on their backs over the most gruelling trails load which weigh 100 lb. or more, kept in place by broad bands crossing thei chests and foreheads. These Indians consider four wives an ideal number and the local Padre (a Spanish Basque) told me that, although they usuall bring their children to be baptized, they refuse marriage by the Church because monogamous marriage as a Sacrament is something they naturall do not understand, while he with the best will in the world could not bles three unorthodox unions.

We left for Moyobamba on the fourth day with eleven Carguero Indian and their chief's wife and sister-in-law. A short distance after leaving Balsa puerto the trail goes through a shallow stream about 12 feet broad and plunge at once into the forest, following a fantastic course of steep drops and equall steep ascents, running for some distance along the top of a narrow ridge wit the sound of a rushing river on each side below. The view was entirel obscured by dense forest growth, and it was amazing to see how the Indians steadying themselves with their long carved black alpine stocks, carried thei heavy burdens round difficult corners with the trail sometimes broken awa in places and branches of trees interlocked just above the height of a man' head. After five hours of strenuous walking the trail descended abruptly fo some distance, the forest opened out and we found ourselves on a clearing o the left bank of the Yanayacu. The following day the owner of the rude farm house, where we slept in a kind of communal barn, ferried us and our baggag

Crossing the Mayo between Balsapuerto and Moyobamba

The Northern Highway crossing a forest glade

Carguero Indians about to cross ford over the Pumayacu

Group of "Sobralia gloriosa" beside the Chuguyacu

across the Yanayacu and a brief walk through the forest brought us to a right-bank tributary of that river, the Escalerayacu. This river we had to ford nine times in two hours, followed by a terrifically steep climb of about six hours over rocks of red sandstone. At the infrequent places where the eye could command a distant prospect, the scene was one of breath-taking beauty. Immediately below us at the base of a tremendous drop the Yanayacu pushed its circuitous way through the last foothills of the Andes of Maynas, which gradually dwindled into vague irregularities and inconspicuous undulations until the giant Cordilleras melt into an infinite horizon of misty green.

Rain fell during the night and we broke camp and started off in a severe thunderstorm, rather apprehensive about the condition of the Pumayacu, the crossing of which is the most dreaded ford of the whole Northern Highway. The rapid rise of rivers in a region where bridges are non-existent is one of the risks of travel in the Montaña, for during the wet season a traveller can easily be trapped for some days between two rivers, though, provided he has an adequate store of provisions, his position is one of acute discomfort rather than danger. In 1943 I saw a river, which descends from the Volcano Misti, above Arequipa, in the morning a trickle less than a foot high, in the afternoon a raging destructive torrent at least 30 feet high, and the following morning back to almost its normal size. Luckily the rain had been insufficient to cause any serious rise in the river and we forded the redoubtable Pumayacu without much difficulty, though cautiously and glad to find ourselves safely on its left bank. The ford is about 20 yards across. Above it the river forms a great dark pool, round which the foam-flecked water eddies and swirls. The downstream rim of the pool is a horseshoe-shaped ledge of rock about 2 feet wide—the ford by which the river is crossed. Immediately below the ford, where the pull of the current is very perceptible, the river tips over and races down a not quite perpendicular surface of smooth, water-worn rock, perhaps 40 yards in length; then with a roar it breaks suddenly into a fighting torrent, forces a violent way through a rocky barrier and falls some 150 feet into the valley below, where it comes to rest at the foot of a great cliff, propped up at its base by giant boulders. If the river rose 2 feet the crossing would be hazardous, if 3 feet it would be almost impossible. After crossing the ford I had the joy of seeing for the first time in its native haunts a lovely group of *Eucharis grandiflora*, commonly called the Eucharis Lily, its star-like white flowers with their pale green pistillate cups the only visible flowers in the green twilight of the forest.

The afternoon brought us to the Chuguyacu, a narrow shallow river with the water hardly knee high. After fording this river eleven times, the trail again dived into the forest, bringing us in the late afternoon to the right bank of the Mashuyacu, a more imposing river, some 40 yards wide. This river we had to ford twice, the second time just opposite a rude tambo where we spent the night. With the river low it presented no difficulty, though the water was waist high in places.

The next two days involved strenuous walking from sunrise to sunset, plodding on hour after hour up and down steep ravines, along a trail often knee deep in mud. There was no sound but the steady drip from water-sodden leaves and a constant patter of rain, no escape for the eye—only a few yards

ahead a curtain of impenetrable green with ghostly trees smothered in epiphytic ferns, bromeliads, orchids, and aroids, and long dilapidated lianes dangling from their branches, fantastic as a hangman's noose and motionless as the wreckage of distorted cables.

On the morning of the sixth day, after a night spent in a rude shelter knocked up on the steep and greasy side of a ravine, surrounded by tall, dripping trees, day broke with golden splendour. The Indians, knowing that the worst part of the trail was behind us, were in high spirits, laughing and chattering like a nest of jays as they drank their morning *Masata*, without which they never travel. Masata is made by mixing with water a soft, cheese-like preparation of yuca, which they carry wrapped in banana leaves. The yuca roots are peeled, boiled and mashed, and then chewed by Indian women, who spit the masticated pulp into earthenware bowls, where it is left from four to six days, during which time the action of the human saliva produces the desired fermentation. It is said to be both nourishing and stimulating.

After trudging for an hour or two through the same dense vegetation over the same muddy, difficult trail, the forest began to thin out, and soon we were able, for the first time since leaving the Escalera de Jesus, to enjoy a distant prospect of sunlit hills showing through an ethereal blue haze, which brought to mind, on a grander scale, Tuscany in the autumn. That evening we reached the headwaters of the Yanayacu, crossed its gorge, 60–80 feet deep, by a log bridge and slept at a small farm on the left bank.

The following day we set forth at sunrise and after some easy, pleasant going over dry sandy country, many acres of which were covered with bracken 6 feet high, we reached the Mayo and were ferried across in canoes to its right bank and arrived about noon at Moyobamba.

I have dwelt at some length on the Balsapuerto to Moyobamba section of the Via del Norte because it is the most difficult and arduous part of the journey. The weather on the whole had favoured us, and rivers were low after three weeks of an exceptionally light rainfall, so it is not difficult to imagine what conditions must be during the rainy season nor to understand, when the Northern Highway, and later the Pichis trail, were the only two ways over, why Peru's Amazonian provinces for four centuries had almost no contact with the capital.

Moyobamba has a population of some seven thousand. The name is a corruption of the old Quichua words *Muyu* and *Pampa*, meaning garden of the plain, as the town was called in the days when the armies of the great Inca, Tupac Yupanqui, made expeditions to subdue this part of the country, in accordance with Cuzco's traditional policy of extending the Cordillera Empire by pushing into the Montaña. It is not known if the present site is the same as the one on which the ancient Muyupampa stood, but for obvious geographical reasons it could not have been far distant. What never ceases to impress me is the fact that the indomitable Conquistadores five years only after the reduction of Peru, if we date the collapse of the Inca Empire from 1533, the year of the capture and murder of Atahualpa, could send an expedition under Alonso de Alvarado into the heart of the difficult Andes of Maynas, where they founded and laid out the present town of Moyobamba.

A traveller wrote, some seventy years ago, that Moyobamba was as famous

for its execrable roads as for its excellent Panama hats. The fame of its roads is still unchanged, but Rioja, a day's ride away to the west, has become the centre of the hat industry, though the palm-like plant, *Carludovica palmata*, from which the fibre is obtained is still cultivated round Moyobamba. Only the unfolding white leaves from the heart of the plant are used; after being torn into very narrow strips, they are boiled and bleached in the sun.

Moyobamba is situated on a fertile plain, where maize, sugar-cane, cotton, coffee, and a little tobacco for local consumption are cultivated. The vanilla orchid is frequent, but not cultivated. The elevation is some 2800 feet and the mean temperature 77° F. The plain is watered by the Indoche and Mayo rivers, and a sugar-loaf shaped mountain, El Morro, dominates the landscape. The town covers a large area and an extensive part of its outskirts is scored with large, steep gullies, constantly increasing in size through erosion of the light, friable soil. These gullies often involve long detours to get from one house to another, which in point of distance are only 20 or 30 yards apart. Many of the streets are cobbled and the whitewashed houses in the middle of the town are frequently built with two storeys and have balconies. Nearly all have wide eaves and small gardens of a strictly utilitarian nature, though sometimes orchids brought from the forest are cultivated epiphytically on fruit trees.

We spent ten happy days at Moyobamba and left the pleasant little Montaña town with real regret for the next stage of the Northern Highway, six days by mule to the town of Chachapoyas. Our little cavalcade consisted of eight mules, two ponies, and four muleteers, all brought from Chachapoyas, where a Señor Quiroz has something like a monopoly of mule and horse transport on the trail between Moyobamba and Cajamarca.

The trail from Moyobamba to Rioja, where we spent the first night, is fairly easy going, although, in spite of the fact that no rain had fallen for the unusually long period of nearly three weeks, two mules sank in the mud up to their girths and had to have their packs removed before they could be extricated. Rioja is just a straggling Montaña town of some two thousand five hundred inhabitants, built on a little sandstone elevation near the Tonchinan river. It has a perfect climate and the soil is so fertile that it will grow three crops of maize in a year. Many varieties of fruit prosper there including mangoes, avocado pears, bread-fruit, pineapples, bananas, lemons, papayas, passion-fruit, and oranges. At the village of Calzada, between Moyobamba and Rioja, we bought twenty oranges for a penny. Owing to absence of transport all fruit is grown for local consumption only. But good quality Panama hats are made for export. Cheap coarse hats are also manufactured and sell for the equivalent of 15*s*. These take about a week to finish, whereas those of fine quality sell for £3–£4 and cannot be made in less than a month to six weeks.

The following day we started before sunrise. An easy two hours across flat, sandy country, covered with bracken and low scrub, where I had the good fortune to collect a new genus of Melastomaceae, brought us to the Rio Negro, a crystal-clear right-bank affluent of the Mayo. From here the trail scrambles up the side of a precipitous ravine. Much of it goes between rocky walls sometimes 20 feet high, worn down by water and the passing of genera-

tions of pack mules. All the way up the packs knocked and scraped against the rocks, as our animals stumbled and struggled round hairpin bends. There are few places where it is possible for two mule trains to pass, and the raucous shouts of the muleteers are meant to be heard half a mile away, giving warning in time to halt on-coming animals at the rare places where two mules can pass one another in safety. The summit of the *cuesta*, which we reached in about four hours after a hard stretch among slippery stones and boulders, well-named the Rio-Seco or Dry river, is known as La Ventana. The day was clear and sunny and a glorious prospect opened at our feet of deep, forest-clad ravines with tall palm trees in the foreground, falling away steeply to the valley of the Mayo.

From here to the poverty-stricken village of Ushcu the going is bad beyond belief, the mules almost up to their girths in mud-holes with the trail hardly discernible at times, struggling to hold its own among fallen trees, streams, and the invading forest. Steep ascents were followed by abrupt rocky descents, where the weary mules often stood hesitating whether to jump, slide, or pick a precarious foothold. We arrived at Ushcu just as a brief tropical dusk was beginning to cast its sudden chill upon the air, and slept in a loft with a mud floor, attached to the Telegraph Office, which consists of one small room, used as office, living-room, and bedroom by the Postmaster and his wife, and, when we were there, also by an infant twelve days old. The single telegraph line, through which Ushcu maintains a precarious contact with the outside world, follows an erratic course, looped up to trees, half-rotten poles, and anything else that answers the purpose.

The following day, after six hours over a trail as bad as the day before, including a stretch up the dry bed of a river, which higher up suddenly disappears underground, we reached a lovely open glade in the forest, and camped beside a swift-running stream amid a riot of flowers, among which scarlet fuchsias and Tyrian purple tibouchinas grew conspicuously, on trunks of trees, in crevices in the rocks, in the ground, and perched on moss-laden branches.

The next day the trail struggles for hours up a steep cuesta, while the forest gradually thins out, as tropical plant life yields to sub-tropical forms, until, after an arduous stretch in a heavy downpour, which soaked us to the skin, we arrived at the summit of the Piscohuañuno pass, which means in the Quichua tongue "The Place where the Birds Die." This pass, just short of 12,000 feet above sea-level, is in the range which forms the watershed between the Upper Marañon tributaries and the Huallaga affluents. We camped on the Molinopampa side of the pass at an elevation of some 11,000 feet, in a little depression on the steep mountain-side near a small corral and diminutive tarn where the animals could drink. It would be difficult to imagine a greater contrast between this forlorn, wind-swept moorland country, with its blackish-brown rocks of slate, short, coarse grass and small stunted shrubs, and the steamy atmosphere of the Amazonian forest with its luxuriant tropical plant-life and brilliant floral display of our camping ground of the previous night.

This night was one of misery, owing to an icy wind. Even the muleteers inured to the hardships of the Northern Highway, cursed the place. But

Balsapuerto on the Cachiyacu

Church at Leimebamba, Utcubamba valley

Section of the Northern Highway in the Cordilleras

Cacti in the desert zone, Chillon valley near Lima

ich compensation came with the morning when, bathed in a flood of golden ight, peak after peak, and range after range, stretched out before us.

The trail down from Piscohuañuno to the valley of the Ventilla is strenuous or those conscious of advancing years. At the bottom of the descent the raveller follows the Ventilla's left bank for 3 or 4 miles through a scene of lmost English pastoral tranquillity with cattle grazing peacefully in rich-ooking pasture, which changes abruptly, with one of those transitions haracteristic of the Via del Norte, as the trail suddenly leaves the river and urns up another precipitous cuesta where only a goat or chamois would feel t home. This is followed by 3 or 4 miles easy going along the river valley nd beside a lake, upon which swam many duck and water-fowl, until a ittle before sunset we reached the village of Molinopampa, where we spent he night in the house of our chief muleteer, lured thither by his assurance hat his was the only house in Molinopampa that was not infested by ticks. Molinopampa is a rather attractive village with a semi-Indian population, on he Ventilla's left bank, surrounded by thickly wooded mountains. Its small hatched houses are built each side of broad grass streets, eaten close by locks of small black and white sheep. A curious feature of the place is a hardy nvader in the form of the common white arum lily, which has naturalized tself and was flowering in its thousands in the grass streets on the outskirts f the village.

The next day the trail, after following for a few miles the right bank of the Ventilla, scrambled up a kind of rough hewn staircase of rock, up which only llama or an Andean-bred mule could have carried a pack, to reach the alley of the Soloco river. Here the going was a pure joy along a grass-grown rail beside the river's bank, where custard-apple trees (*Annona Cherimolia*) rew in profusion and a tillandsia with rosy-heliotrope coloured flowers lourished epiphytically on every tree. The trail all day followed a steady pward gradient, but the last cuesta from the Soloco's left bank, zigzagging p a barren mountain-side covered with enormous cacti, entailed such evere collar-work that I preferred to walk rather than trust myself to the ule, where one false step would almost certainly have involved a broken imb or neck. This is one of the stretches of the Northern Highway, which aimondi, writing in 1868, describes as "passing the limits of bad and only be described as horrible," and he adds that then, as now, a traveller had r better walk than ride.

From the top of this cuesta, which must be some 8000 feet above sea-level, easy switchback mud road brought us at the end of an eight hours' ride the town of Chachapoyas.

Chachapoyas, in addition to being a provincial capital, is also the seat of bishopric; but, in spite of a large plaza, a cathedral of minor pretensions, a ibrary, and some ten thousand inhabitants, the place is little more than an vergrown Indian village with open drains running down the middle of obbled streets and small, jerry-built adobe houses, vulnerable to even minor rthquakes, which are frequent here. The town is pleasantly situated at an evation of 7640 feet in a depression in the midst of the Cordilleras with a althy climate and a mean temperature of 62° F. The population looks of tter physique than the people of Moyobamba, and most of the women have

a graceful upright carriage, due probably to walking with baskets balanced on their heads, while the men are of picturesque appearance in their black, brown, or dark green ponchos and wide-brimmed straw hats.

After five nights at Chachapoyas we set out with a fresh lot of mules for a ride of four strenuous days to Celendin. The first and second days the trail works slowly up the Utcubamba valley. This river is a right-bank affluent of the Marañon, as the Amazon is called here. The trail follows the river's winding course, except where small gorges force it to worm a switchback way round the steep mountain-side. A small section of the new highway on the Utcubamba's right bank was almost finished in 1938, though at that time it began and ended nowhere in particular. The first night out we slept under a rude shelter beside the river, the second night in the very dirty village of Leimebamba.

The third day was one of the peak points of the whole Northern Highway. Early morning began with a steep pull up a long cuesta until we reached the sparkling beginning of the Utcubamba in a narrow, grassy valley. Here the forest, which had been gradually thinning out, abruptly ended. From this point the ascent, after a mile of easy, almost level going, entailed some rather stiff collar-work until we reached at 12,170 feet the top of the Calla-Calla pass. This pass has an evil reputation on account of a prevalent icy wind which can be fatal to a traveller caught wet and insufficiently clad on its inhospitable heights. But the day we crossed it, although I was glad of a wind-jacket and poncho, the sky was clear and the wind sighed rather than blew, while the sun shone upon a panorama which no pen could describe. There was a silence so absolute that I shall always think of the place as the pass of the Great Silence.

From the top of the Calla-Calla pass to where we crossed the clearly marked divide into the valley of the Marañon, the going was easy. Even over a long stretch of corrugated trail the dry season made it possible to walk without much difficulty, and even to collect a few specimens, which included a fine shrubby calceolaria, a cornflower-blue lupin growing in great drifts, two or three species of terrestrial yellow orchids (oncidiums and epidendrums) and a tropical mistletoe, which in one place hung in great parasitic bunches of glowing scarlet from every tree and bush.

A very steep drop (*bajada malissima*, as our muleteers called it) began just after crossing the divide. The surface was so rough and loose that to ride down it would have invited disaster, so we dismounted and let the mules take their own line, while we slid and stumbled down this incredible Andean trade-route until, after feeling our way round a shoulder of rock, we suddenly caught our breath, there, still a five hours' walk below us, a tiny silver serpent, the Amazon, threaded its way through the mountains.

We spent that night at a derelict farm on the mountain-side and slept in a ramshackle tambo, where rain from frequent showers leaked through its thatch and a brood of half-grown chickens roosting above us kept tumbling on our heads.

After a restless night, we rose at 4 a.m. and started before sunrise down the bed of a small stream, leaving the muleteers to follow with the animals, picking our way by the light of electric torches. As we descended the trail, the

mountain-sides became more and more barren, until, after going through a zone where the vegetation is dominated by cacti, we reached the village of Balsas on the Marañon's right bank, only some 3100 feet above sea-level, a descent of nearly 9000 feet since the previous morning. Balsas is a sordid, straggling village and its inhabitants make a painful impression of squalor, poverty, and disease. We had been warned not to pass a night there on account of the risk of malarial infection, and worse, for two individuals I saw there appeared to be suffering from Uta.

The dry, hot valleys of the Marañon, more particularly of the Jaen region, are reputed to be bad centres for contracting Uta or Tropical Sore, a malady caused by a protozoan parasite, *Leishmania*, here probably *L. brasiliensis*. Travellers are said to be more liable to infection than inhabitants of these valleys. Unlike anopheles, the carrier of malaria, which infects by its saliva trickling into the minute wound it makes, the sand-fly carrier of Uta injects the germ into its victim's blood-stream. Many local remedies are used for treating symptoms, including an ointment, the basis of which is a butter made from woman's milk. The approved medical treatment is intravenous injections of antimony. Infection is believed locally to be derived from a plant, just as a species of cactus is often said to be found in the districts where Verruga Peruana is prevalent. Although highly improbable, it is just remotely possible that in both cases the sources of infection may exist on plants and be conveyed thence to human beings by the carriers after undergoing changes in their organisms. In both diseases elevation is a limiting factor to infection. The carrier of Verruga is said rarely to be found below 2500 feet or above 7500 feet. It is abroad only between sunset and sunrise.

We rode through the straggling village half an hour upstream along the river's right bank and crossed it by a reasonably solid suspension bridge, which swayed beneath our mules' tread. The Marañon where it is bridged at Balsas is not more than 50 yards across. It is a characteristically turbulent mountain torrent with clear, green pools and a succession of sparkling rapids flowing between boulders torn from the mountain-sides. Here there is no hint of its great Atlantic destiny.

The cuesta leading up the left bank of the Marañon to the summit overlooking the gorge can only be described as terrific. It took us seven hours to ride up a zigzag trail, which from below looked impossible for heavily laden animals, before we reached the plateau above Celendin. Half-way up the cuesta an army of road-makers with dynamite, pick, and shovel were working on a stretch of the new highway from Celendin, which I am told is now completed as far as Balsas. The day seemed interminable and our progress was slow, for we had to halt every few minutes to rest the exhausted mules; but just before sunset we stood upon the summit and were again rewarded by a majestic mountain panorama. We longed to linger, but the sun was already low in the west and the muleteers warned us of a long, rough descent to Celendin.

Celendin, 8465 feet above sea-level, with some 5200 inhabitants, has nothing to interest the traveller, except the manufacture of Panama hats, which are of superlative quality. The only hotel was filthy, and the only restaurant was, if possible, worse with its swarm of flies. This place was, I think, responsible for a severe attack of amoebic dysentery, which I developed

just before arriving back in Lima. Risk of this infection is one of the gre drawbacks to travel in Peru, for with every precaution, such as never eatin strawberries or drinking unboiled water, flies crawling over bread or othe food can convey infection.

After two nights at Celendin we left by car for Cajamarca, a run of four t five hours. The road was narrow with a bad surface, with room, at ra intervals only, for two cars to pass with safety. As we followed its windin course mile after mile round arid, sun-baked shoulders or zigzagged up th sides of rocky, barren mountains to a height of 14,000 feet, without a sig of human habitation, one realized that here, where even an Indian of th Cordilleras cannot scratch a living, the finest roads in the world could no except through the exploitation of mineral wealth, bring prosperity. O approaching Cajamarca signs of cultivation began to appear, increasing unti the traveller reaches, at an elevation of some 9500 feet, the plateau, which fo centuries has been the home of a prosperous agricultural community. Perhap intermontane depression on a plateau would be a better description, fo although some 15–20 miles long with an average breadth of some 8 miles, th cultivated area is surrounded by higher mountains and is part of that rugge upland traversed by a number of almost parallel ranges with a general north to south direction, which begins not far from the Pacific coast and extend eastward for some 130 miles before petering out on the great Amazonian plain Wheat, barley, and potatoes are the main crops of the Cajamarca depressio and the elevation is excellent for the breeding of horses, cattle, and sheep.

The town itself, which is the largest one of the whole Northern Highway has some fourteen thousand inhabitants. In spite of a pleasantly austere unfinished cathedral and a few fine, decaying houses with ancient doors o armorial grandeur, the dominant impression is of an Indian town overlaid b a rather cracked Spanish Colonial veneer.

There are hot sulphur springs and a bathing establishment about $2\frac{1}{2}$ mile outside the city. It was to these baths that the Inca Atahualpa and his Court ha retired when Pizarro and his followers arrived at Cajamarca on 15 Novembe 1532. The grim story of the treacherous attack on the Inca, his capture an judicial murder are too well known to be re-told.

From Cajamarca to Trujillo the road climbs from 9200 feet to som 14,200 feet, and I confess to having felt thoroughly scared whenever th chauffeur's help, a small boy aged fourteen who travelled on the step of th hired Buick, jumped down at the frequent corkscrew bends with a larg stone, which he hastily placed behind a rear wheel, each time the car had t be backed to the edge of an abyss to allow it to make a bend. Even th driver's encouraging remark "Fear not! The car is ancient, but the brake should hold," was only moderately reassuring.

After Chilete the road runs down a steep and difficult descent from the to of the divide until it reaches the Chicama valley, where it passes down gentle incline through the famous sugar plantations of the Casa Grand property, one of the largest sugar-producing estates in the world. At the en of the valley it joins the Pan-American coastal road and, passing near th extensive ruins of the pre-Inca city of Chan-Chan, reaches Trujillo, whe the last stage of the Northern Highway ends at only 200 feet above sea-leve

80°
ECUADOR
Tumbes
Talara
Paita
Piura
Pan-American Highway
Huancabamba
R. Marañon
Jaen
R. Utcubamba
Chachapoya
Chiclayo
Celendin
Cajamarca
2750
Chilete
Magdalena
Pacasmayo
R. Chicama
Trujillo
Salaverry
Viru
Chimbote
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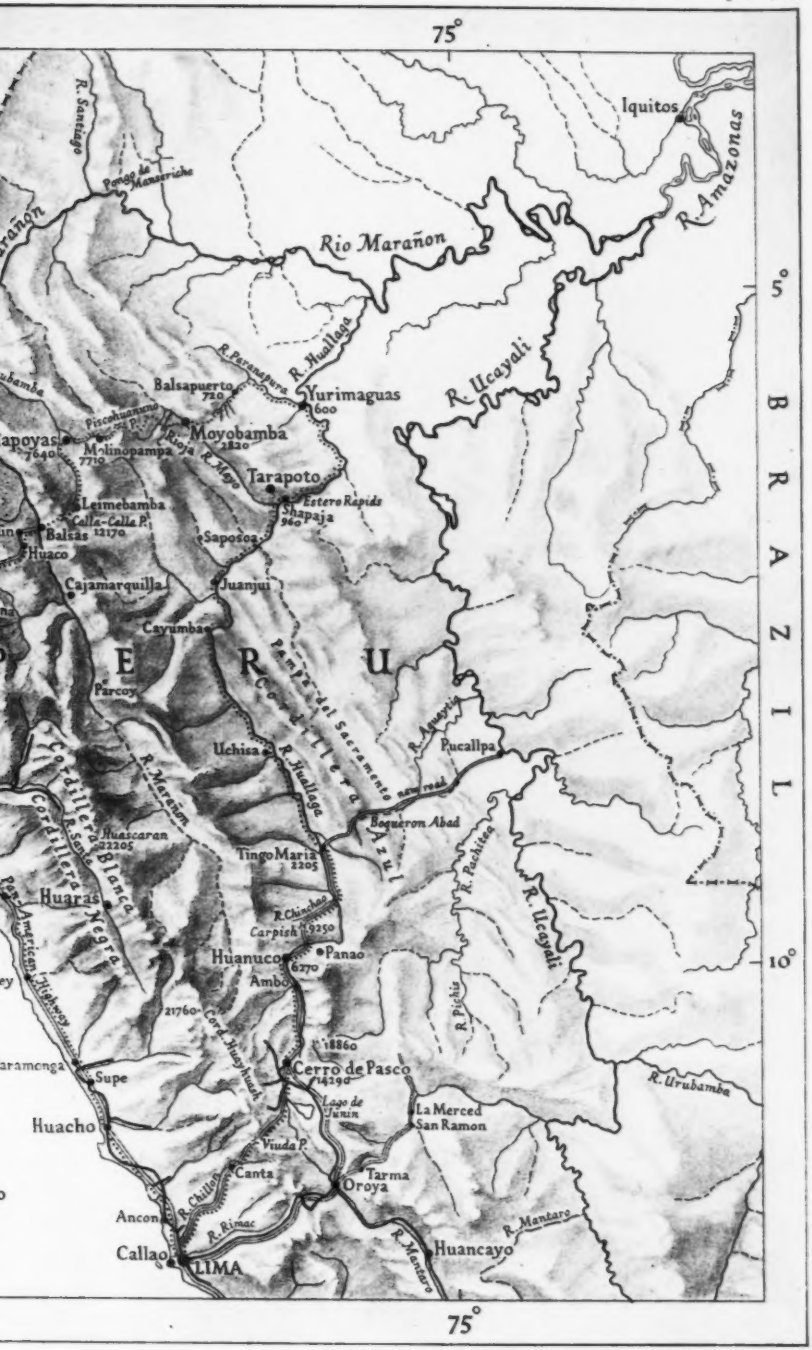


THE NORTHERN HIGHWAY OF PERU
Sandeman

From Trujillo, which was founded by Francisco Pizarro in 1535 and named by him after his natal town in Spain, Lima can now be reached in one day by car over an asphalt highway. In 1938 only small stretches north of Ancon were completed and two gruelling days were necessary, the second one of sixteen hours, ploughing through a barren waste of rocks and stones and sand, to reach the capital. Here we were back once more in that strange coastal desert, which during winter months combines the unusual phenomenon of barren, waterless, Sahara-like country with a veiled sun and humid atmosphere.

The last day seemed interminable. In a district known as the Infernillo we stuck fast trying to make a steep ascent with a very loose surface, luckily near a lorry stranded there for the third day. The driver and two of his men helped to unload the car and got us started again. We travelled through a desolate waste of sand and stones, littered with the bleached bones of dead animals, human skulls, bits of crude pottery, dreadful rags, and debris from rifled graves. The coastal desert of Peru is one vast graveyard of vanished towns and peoples.

Dusk came on apace and a thick, clammy fog drifted in from the ocean and shrouded the desolate country in an impenetrable veil. A bridge over a stream which we had to cross having broken down, we were forced to make a long detour. The driver mistook the way, not unnaturally on a foggy night in a district where there was no way, but just as we were contemplating spending the night in the desert a distant light, where a patch of fog lifted, shone in the darkness. Laboriously we lurched through the sand to it and found a shack where some road-makers were spending the night. One of them, with characteristic Peruvian courtesy, guided us to a track, which ultimately brought us to the coastal highway and thence in a long hour back to the familiar streets and well-lit squares of Lima.

DISCUSSION

Before the paper the PRESIDENT (The Rt. Hon. Sir GEORGE CLERK) said: Our lecturer this evening, Mr. Christopher Sandeman, is one of the few travellers to have traversed the Huallaga, an important tributary of the Marañon, throughout its course. His extensive journey through Peru in 1938 was made on mule back, on foot, and by raft down the river. He is not going however to confine himself to incidents of this journey, but will also deal in general with the development of this hitherto rather isolated region of Peru. Much has been done lately to improve its communications with the outside world, particularly with the Amazon, and Mr. Sandeman can assess the value of this work with authority. In addition to his primary interest, botanical collecting, he is keenly appreciative of historical associations and of life in the more remote regions. We look forward to a varied and instructive paper.

Mr. Sandeman then read the paper printed above.

The PRESIDENT: We have had a wonderful lecture. One of the photographs which the lecturer showed was of a church. I am sure you appreciated the beauty, the perfection of the design of that façade, and when you think that that was erected some hundreds of years ago in a country of such difficulty of access as our lecturer has just described to us, you must admit that the builders were a very great people.

Our lecturer has given us the impression that it was a roughish road, but that

on the whole it was not too bad. The truth is, of course, that it was full of hardship, not to say danger, and only somebody with the proper attributes of the real traveller could have accomplished the journey. What he completely omitted to say was that all this time, while he was evidently having quite enough to do to get along at all, he was very busily engaged in most important and valuable botanical research which to-night appears to have been a side issue, but was really the purpose of his expedition.

It gives us an insight into a part of the world of which some of us know very little. I think that so long as we have people who, like Mr. Sandeman, are ready to take the discomfort, the inconveniences, and the risks of such journeys we can be satisfied that the Fellowship of our Society will go on and prosper.

WAR-TIME EXPLORATION WITH THE SUDAN DEFENCE FORCE IN THE LIBYAN DESERT, 1941–43

CAPTAIN J. W. WRIGHT, R.E.

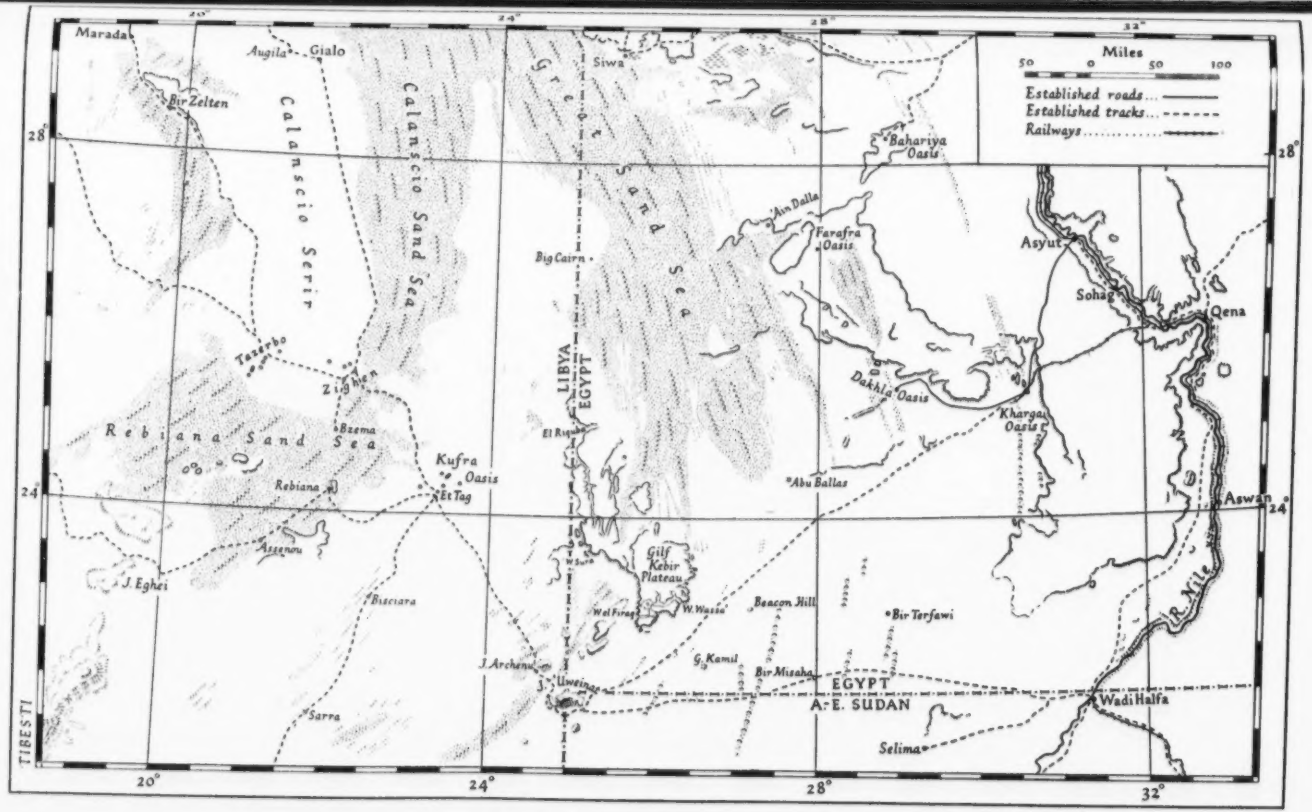
TWO recent papers, one by Major W. B. K. Shaw, in the November-December 1943 number of the *Geographical Journal*, and the other by Brigadier R. A. Bagnold, in the January–February 1945 number, referred to the actual survey work carried out by the Long Range Desert Group in addition to the information which they collected incidentally in the course of operational patrols. The part played by the Sudan Defence Force in this work can now also be described, and a brief account of the surveys which they carried out may be of interest. A full description, like the maps which were made, must await publication till after the war.

Kufra was taken by the Free French, aided by the L.R.D.G., in March 1941, and in July the garrison duties were taken over by a battalion of the S.D.F. I was attached to this battalion as survey and navigating officer until October 1941, having been lent by the Sudan Survey Department to the S.D.F., and was engaged in similar work during the second half of 1942. During these two periods the 1/500,000 2-degree square sheets, Tazerbo and Bisciara, and half of each of the sheets Assénou and Archenu, were surveyed by S.D.F. parties. Lieut. Lazarus, the R.E. officer attached to the L.R.D.G., surveyed the two complete sheets, Calanscio Serir and Cufra,[1] and half each of two others, Big Cairn and El Riquba. Thus we covered between us an area of about 100,000 square miles, roughly centred on the Kufra oases, and, in addition, information was obtained for other sheets in the course of various patrols and convoys. I also made large-scale maps of the main Kufra oasis and of Gialo for the use of our garrisons.

Three survey journeys in 1941

During its occupation by the S.D.F., Kufra was maintained from Wadi Halfa, and one of the first pieces of survey work, in September 1941, was to

[1] Kufra is the generally accepted English spelling, but the Italian names of these sheets were adopted without any change.


Miles
50 0 50 100
Established roads
Established tracks
Railways
Marada
Augila
Gialo
Bir Zelten
Calanscio Serir
Calanscio Sand Sea
Siwa
Great Sand Sea
Bahariya Oasis
Ain Dalla
Farafra Oasis
Asyut
Sohag
Qena
Big Cairn
LIBYA
EGYPT
Tazerbo
Zighen
Dakhla Oasis
Kharga Oasis
Rebiana Sand Sea
Bzema
El Rheb
Kufra Oasis
Et Tag
Rebiana
Abu Ballas
Aswan
Assenou
Gilf Kebir Plateau
W. Sura
J. Eghei
Bisciara
Wel Firag
W. Wassa
Beacon Hill
Bir Tarfawi
Nile
J. Archenu
G. Kamil
Bir Misaha
Uweinat
EGYPT
A.-E. SUDAN
Wadi Halfa
Sarra
Selima
TIBESTI
20°
24°
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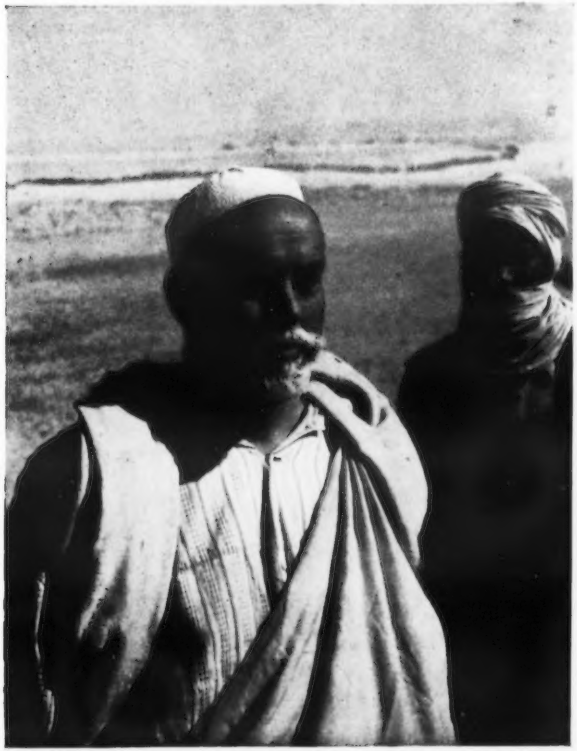


Mahomed Zerawi, Hassanein Bey's guide from Kufra to El Fasher in 1923, now living at Awuila

Looking south from northern wireless mast, El Tag fort, Kufra

improve the maps of this route. A fortnight's work south-east of Kufra resulted in the completion of the Archenu sheet, of which the eastern half had already been largely supplied by Clayton in his outstanding single day's traverse of the western cliff of the Gilf Kebir in 1931.[1] It was found that this cliff was faced by another, not quite so high, which extended to the south-west from Wadi Surá for about 50 miles. The route south of this, used by Almàsy to fetch petrol from Kufra on the same expedition, was rediscovered and mapped; the only available descriptions of it were too brief to be of any value in locating it.

The great line of dunes between Wadi Sura and 'Uweinat was also mapped in detail, and it was confirmed that this barrier was quite uncrossable by wheeled transport for a distance of about 50 miles. The confused area of dunes, sand sheet, and granite mountains to the west of this was also mapped, but no unexpected discoveries were made.

Eighty miles to the west of the main Kufra oasis of El Tag lies Rebiana, in a hollow dominated by a line of steep cliffs. It can only be reached from Kufra by crossing a part of the Rebiana Sand Sea, where the dune lines are scattered and fairly flat. The Italians had marked a route through, but this was of course much softened by use, and it was therefore desirable to explore alternative, unused, crossings. Another 70 miles to the south-west was the almost unknown well of Assenou, where it was rumoured that an Italian landing-ground had been laid out. There was not even a rough 1/400,000 map of this area, and it seemed advisable to get more details; so the second survey journey, early in October 1941, was made in this direction.

Bimbashi R. G. Maxwell, of the S.D.F., accompanied me, and we collected a Tibu sheikh from Rebiana, who guided us to the well. The dune lines here run almost exactly south-west, so our route lay between them and it was only a few hours' run. Assenou is a deep well (about 30 metres, though the water-level varies) similar to those at Sarra and Bisciara, and like them dug by the Senussi at the beginning of this century. There is no vegetation or permanent settlement, but the well appears to be used quite frequently by parties of Tibu travelling between Kufra and the outlying oases of Tibesti.

We continued to the south and mapped the northern part of a hitherto unknown plateau about half the size of the Gilf Kebir, with cliffs, particularly in the west, over 100 metres high. The southern edge of the Rebiana Sand Sea runs north of this plateau, but one of the seif dune lines, by some curious freak, continues across it for 16 miles beyond the others. The western edge of the plateau was difficult to descend, and for two days we used only one vehicle, leaving the other at a central spot on the plateau. A new direct route to Assenou from Kufra was found which avoided all the dunes and so could be used if desired by heavy vehicles.

I had hoped, after returning to Kufra for more petrol and stores, to continue farther south and west into completely unknown country, but it was decided that the area was too far away to be sufficiently important, and that the Italian maps of the country near Kufra were so bad that they must be im-

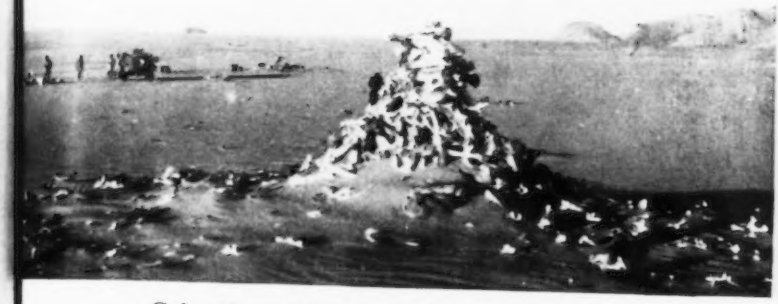
[1] P. A. Clayton, "The western side of the Gilf Kebir." *Geogr. J.* 81 (1933) 254.

proved first. So I left Kufra, accompanied by Bimbashi W. Williams, in the middle of October 1941 to try to cover the whole Tazerbo sheet in one trip, as it had been agreed that Lieut. Lazarus would be responsible for the sheet containing Kufra itself.

Tazerbo lies at the southern end of the Calanscio Serir, an immense featureless gravel plain which stretches northwards for 250 miles to Gialo. Southwards this plain grades almost imperceptibly into the Rebiana Sand Sea. At first it becomes sandier and marked by undulations, then these begin to steepen like an ocean swell approaching a shelving coast, until they "break," and actual seif dunes begin to form on their crests. Westwards the transition is more abrupt, as if the flank of the swell were passing over a sharply defined shallow area, so that the undulations become regular lines of seif dunes with almost continuously sharp crests. We mapped the limits of these different areas and also mapped in detail a large area of gravel plain and hills lying in the middle of the sea about 60 miles south of Tazerbo; this "island" had been only very roughly indicated on the Italian map. To the west of it the sand sea was more confused and with larger dunes than I have seen anywhere else. One dune measured with the plane-table and clinometer and also by aneroid, we found to be 140 metres from its crest to the desert floor. A dune height greater than this, and obtained by actual measurement, has not often been recorded.

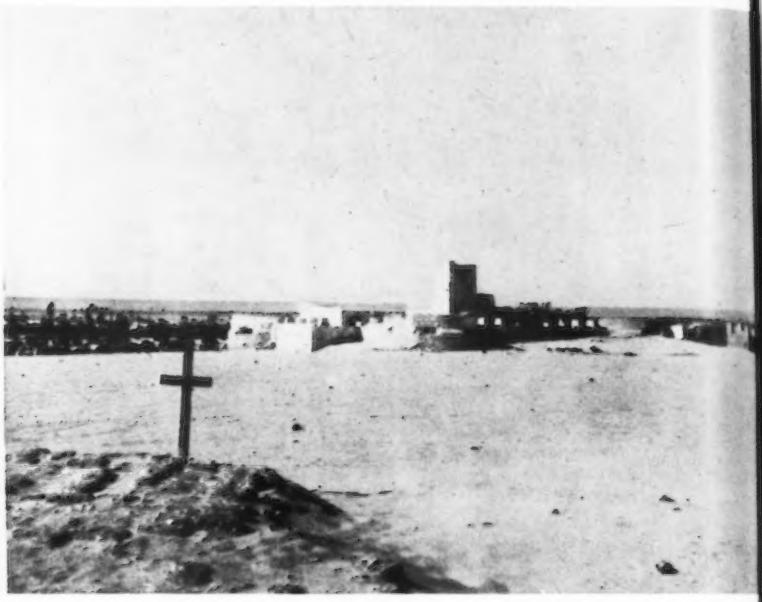
After returning to Tazerbo we set off westwards, intending to make a traverse across the sand sea to the west of our previous course and to get an idea of the character of the dunes in that area. Unfortunately, after travelling only 60 miles, we brought the journey to an abrupt end by crashing over the edge of a steep dune. The leading car, in which Williams and I were riding, was completely wrecked, and an immediate retreat to Tazerbo on the lorry was necessary. Three days after arriving there I succumbed to a violent attack of dysentery which put any survey by the S.D.F. out of the question for nearly six months, since there was no replacement available.

These crashes were a fairly common occurrence among all units during their first six months in the central desert. They were due chiefly to a natural desire to avoid unnecessary "sticks" in soft sand which made one drive at a fairly high constant speed when among dunes, and also to the absence of all shadows when the sun was high (above 32 degrees). The cols in these dune lines were always soft and so had to be rushed; usually one could make a fair estimate of the height, and of the steepness of the far side of the col. We did not realize however on this occasion that the dune line was the last of several along the top of a whale back, so that we were actually about 20 feet above the desert floor when we crossed the col, instead of only the 5 or 6 that it appeared. The car was going just fast enough to leave the ground altogether, and it dived on to the hard gravel floor just beyond the bottom of the dune. Fortunately the second car stopped on the crest in time to avoid running into us, and no one was seriously hurt. Several S.D.F. and L.R.D.G. officers crashed like this at one time or another, usually after a month or two's experience had given confidence in knowledge of the dunes. Lately Major Maxwell-Darling, Sudan Government entomologist and scientific leader of the anti-locust party in Sa'udi Arabia, has also qualified as a sand-hopper.



Cairn of camel bones just south of Bisciara well

Cars after crash over dune west of Tazerbo



Augila fort, and oasis beyond

Sand ridges across the Wadi Wassa', Gilf Kebir

Surveys east of Kufra in 1942

The German advance to El 'Alamein made central Libya still an important area in 1942, and there was actually more activity at Kufra during the second half of that year than at any other time.

My first assignment, in June, was to teach an Ordnance recovery section, based at Selima, to navigate, as they had been set the formidable task of collecting the broken-down vehicles scattered over the many different routes which had been used between Wadi Halfa and Kufra. The opportunity was taken to improve the map round Selima, which had always been rather sketchy, though the position of Selima itself had been fixed astronomically by Newbold and Shaw in 1930,[1] and subsequent determinations by myself and Miskin (also of the Sudan Survey Department) differed only slightly from theirs. I then accompanied a reconnaissance party to 'Uweinat, and was able to spend four days adding detail (on a scale of 1/250,000) to the area between it and the Gilf. We found here a very fine cave, and looked for rock drawings, though without success. On the floor was a hollowed-out stone slab which had clearly been used for grinding up meal. Our Sudanese drivers confirmed this by wanting to use it for this purpose as soon as they saw it. There is no reason of course to suppose that it was ancient, for Tibu had been seen in this area up till the Italian occupation of Kufra.

Neither of these trips was a complete success from a survey point of view, because in both survey had to be subordinated to other work; but the first bore fruit later from the interest inspired in the Ordnance unit for accurate desert navigation (which automatically becomes exploration where the maps are bad). Later this unit was able to make several useful additions to the maps of another part of the convoy route.

On the second trip, and in the course of two journeys with convoys between Wadi Halfa and Kufra, I was able to add miscellaneous information to the Survey of Egypt's 1/500,000 sheet 'Uweinat; but the pioneering of routes in this region had already been done by the leaders of convoys, who were R.A.S.C. officers either attached to, or working with, the S.D.F. Chief among these were Major Lonsdale, and Lieutenants Morpeth and Beattie. As a result of their information and my own journeys, it was definitely established that a great line of barchans stretches without a break from near Beacon Hill to the gap in lat. 22° N., and that there are practicable east–west routes both north and south of it. The northern route passes through the Gilf Kebir via the Wadi Wassa', which runs parallel to the Wadi Firaq and a few miles north of it. Shaw's remark, on p. 171 of his book 'Long Range Desert Group,' that there is no route through the Gilf between Wadi Firaq and Wadi 'Aqaba is therefore a generalization. Actually the Wadi Wassa' was discovered by him in 1935.[2]

Large-scale maps of Gialo and Kufra oases

September and October 1942 were occupied mainly in navigating the preparatory convoys and main party of the S.D.F. which raided Gialo in the

[1] R. A. Bagnold, "Journeys in the Libyan Desert, 1929 and 1930." *Geogr. J.* 78 (1931) 13.

[2] W. B. Kennedy Shaw, "An expedition in the southern Libyan Desert." *Geogr. J.* 87 (1936) 193.

middle of September, simultaneously with other attacks by the L.R.D.G. and other units on various coastal towns. We suffered during this operation from the lack of an adequate map of Gialo itself, since the L.R.D.G. had been unable to make more than a very rough sketch during their previous occupation in 1941, and even this had not been reproduced. It seemed too good an opportunity to miss, when we found ourselves occupying nine-tenths of the oasis, of establishing a few points on the ground, and this I was able to do. These then served to control a series of air photographs which had actually been taken in 1941, and so make it possible to draw a detailed 1/25,000 map which would have served for another similar raid. As it happened, we occupied Gialo peacefully in December, and this map was completed on the ground by plane-table. This and the plane-tabled 1/20,000 map of Kufra, on which I was working at odd intervals during the two years, give quite a clear picture of the lay-out of typical Libyan oases: the Italians had achieved nothing better than sketches on a scale of 1/100,000 during the years of their occupation.

The chief difficulty in surveying this type of oasis, which consists of an area of palms and soft sand surrounded by higher ground, is the palm trees. Any small elevation from which one hopes to get a view merely raises one to a level with their bushy tops, so that often less can be seen there than from ground-level. However the 180-foot wireless masts which the Italians had put on the Kufra fort provided an excellent beacon visible all over the oasis. At Gialo the difficulty was overcome (only after the peaceful occupation) by putting up a number of beacons on the rim of the hollow in which it lies.

Survey of the Bisciara sheet

Between the raid and the final occupation of Gialo I was able to cover almost completely the 1/500,000 sheet south of Kufra, although unfortunately the fair drawing of this was not finished in time for it to be used for the printed version of this sheet, which thus consisted only of a reduction of the Italian 1/400,000 map with a few corrections by the L.R.D.G. The results of the survey showed that the Italian map was very rough; it included all the main features and the astronomical fixes shown were quite accurate, but all features were greatly exaggerated, and very little idea was given of the nature of the country between them.

By the end of 1942 all threat to the Sudan in this area had been effectively removed and there was no excuse for further surveys, so I returned to Khartoum finally on 12 January 1943, and, after a few weeks spent in tidying up the results, was sent off on other work.

Methods of survey

The following short notes on the methods I used are meant to be in the form of a personal commentary on what has already been written in many articles and books about desert navigation generally; they are not intended to be a full description of the methods recommended. It must be remembered that many of the practices outlined here were imposed by the conditions and are far from being ideal, but they would probably have to be used again in a similar war-time survey.

The chief difficulty was the extreme uncertainty of one's plans, for trans-

port and men were often required for other duties, and were sometimes recalled even in the middle of a trip; in this respect the wireless set was a mixed blessing. It was therefore essential to make the most use of a party once it had been got together, and to cover as much ground as possible in the limited time that it would be available. Since the existing maps were extremely poor, even the roughest of surveys would be an improvement on them. The work was in fact exploration rather than survey, and resembled the charting from a ship of a complicated coast known previously in only the most general way.

Apart from this uncertainty, and the general shortage of everything, there was not a very warlike atmosphere; in theory we were behind the enemy lines, but his most advanced posts were several hundred miles away, and only in the early part of 1942 did he show any signs of sending scouting parties down in our direction. Only then did precautions, such as black-out, wireless silence, covering up tracks, etc., have to be observed during these survey trips.

Transport

The vehicles taken were one machine-gun van and one G.S. lorry of the patterns then in use by the Sudan Defence Force motor machine-gun companies. Both were V8 Fords with 30/85 h.p. engines, one on a 112-inch (8 cwt.) chassis and the other on a 134-inch (2 ton) chassis. The bodies were made after standard S.D.F. patterns, chiefly remarkable in that the van had neither windscreen nor hood, and that both carried spare petrol, tyres, spades, sand channels, etc., in brackets outside the body, and thus left room inside for the maximum load. The lorry was fast and so got along through slightly soft sand much better than the four-wheel drive 3-tonners used in convoy work. Desert tyres were of course fitted throughout. A spare pair of sand channels was taken on the lorry and was very useful for working through a long soft patch. This type of lorry easily carried $2\frac{1}{2}$ tons, and we were just able to take enough petrol for 1000 miles for both vehicles, and water for about ten days at 1 gallon per day per man. Usually a well was known to lie within the area to be surveyed, and a normal survey trip could thus last about a fortnight. The usual size of the party was eight, of whom all were Sudanese other ranks except for one other British officer and myself. The Sudanese, considering that only one or two were regular soldiers, were very good; but of course they required more supervision than British troops on such matters as water rationing and vehicle maintenance. On the other hand, they were more used to looking after themselves, and their food and cooking requirements were simple. In our only emergency, when both officers were temporarily incapacitated by a car crash, they managed very well cleaning up the mess until we were able to take charge. Food for three weeks was usually taken in case of accidents or changes of plan, but no refinements, such as those practised by peace-time travellers in the packing of stores and supplies, were possible, and standard army equipment was used. Supplies of spares were at a minimum.

Three vehicles are the recognized number for desert work over long distances, especially when a good fitter and ample spares are not available; but they would have used altogether too much petrol, which had already been carried over 600 miles from rail-head and was correspondingly precious. The

risk involved by taking only two vehicles was considerably decreased by carrying a wireless transmitter, through which daily contact was made with Kufra. There were advantages also, since an extra vehicle is just one more to hold up the party with minor troubles. It never happened that both vehicles broke down simultaneously, and the policy was justified.

Control

Triangulation was clearly impossible in the time at our disposal, and the control was entirely by astronomical observations. They were made at each night's halt following a full day's work, and then had to be computed and plotted at once (for reasons given below), so they had to be reasonably brief. Fortunately I had a good theodolite, a Tavistock $3\frac{1}{4}$-inch of the latest type, with an eye-piece micrometer reading to single seconds; like all my other survey instruments it was the property of the Sudan Survey Department. With this an accuracy of within a quarter of a mile (0·03 of an inch on the scale of the map) was obtained by observing one pair of stars for latitude and another pair for longitude, six pointings being taken to each. Time was recorded by stop-watch and a good half-chronometer watch rated by time signals at least once every evening, and usually before and after the time of observation. With practice I was able to carry out the whole programme of observation and time-keeping myself, and to compute the result to the nearest second of arc in about three hours from the time of setting up the instrument. Since all the observations were on one face the accuracy of the fix was indicated, not by the respective differences between the two values for latitude and longitude, but by the difference between these differences. This second difference seldom exceeded 15 seconds; in fact an error even of a mile was of no great importance in this type of survey.

The compass traverse

Between the astronomical positions a continuous car and sun-compass traverse was run in the usual manner of desert navigation. I agree with Shaw that for this work the Bagnold sun-compass is best, but I think that for ordinary navigational use the Cole Universal compass is at least as accurate and is easier for the uninitiated to understand. The Mark III Cole compass was a very great improvement mechanically on the Mark II, and I navigated with one for a journey of over 600 miles without finding any difficulty in re-setting the compass while the car was in motion.

The Bagnold compass requires tables, and I found those used by the L.R.D.G. were too widely spaced in time and latitude for survey work; for although figures are given in them for interpolation, there is enough to do in taking bearings, etc., while surveying to make simple and almost automatic setting of the compass essential. So I returned to the old idea of a card filled in each day from a book of tables. Davis' tables are unnecessarily precise and detailed for this work, and the old cards had too long a time interval. I therefore drew up new tables and cards designed for use together so that no interpolation was necessary when filling in the card, and so that the intervals in both corresponded roughly to the rate of change of the sun's azimuth. Eventually these tables were printed for use by the S.D.F., but not until after the close of the North African campaign.

Italian petrol pump half-way between Kufra and Gialo

Digging for water 30 miles south of Tazerbo

Gialo village from the south

Italian minefield at Gialo exposed by wind

The following points in booking the traverse seem to have been evolved independently by most desert navigators, and are now fairly standard practice, although they have not been described in previous papers on the subject.

1. Everything is related to the mileages, which are written in a column centrally or on the left of the page; the actual speedometer readings are booked and not turned into distances until the traverse is plotted, and any mistakes can then be detected.

2. When the car's bearing is changed the new bearing is written against the mileage at which the change was made.

3. If the navigating car goes back for any reason, *e.g.* to help one of the others which has stuck, the mileage at which it turns and that at which it returns to the turning point are bracketed together, and the difference put at the side for subtraction from the total of the day's run.

4. The full speedometer reading need only appear at the top of each page, and for other readings the miles and tenths are sufficient, with the tens and hundreds given only when they have changed.

5. Points of detail, descriptions of the going, etc., are all noted against additional speedometer readings.

Adjustment of the traverses

Because we were trying to make a complete survey of an area, instead of reconnoitring a route across it, the adjustment of the traverses presented new problems which the earlier desert traveller did not have to face. As a rule he travelled long distances over often completely unknown country, and seldom crossed his own tracks, so his survey covered only the strip of country visible from his route. His traverse tended to run in a fairly constant direction between consecutive camps, and so could be adjusted quite simply to their fixed positions. Detail close to his route was accurately fixed, that farther away less so, and distant features were only sketched in. He himself was seldom faced with the complications of either a secondary adjustment necessary when two traverses crossed, or with the difficulty of reconciling his earlier sketches of a feature from one viewpoint with its quite different appearance when seen from another. I think it is true to say that, although the course was plotted and the astronomical fixes were worked out roughly in the course of the journey, there was usually no plotting of the survey on such expeditions until the party returned to civilization. The discoveries they made were on such a scale that minor details could be ignored in order to save time *en route*. In surveying an area of which something was already known and in which every important feature had to be shown, we had to overcome these difficulties, and in my view it was best done by plotting the whole map in the field as one went along, and not by making a series of sketches and notes to be worked up later, either in camp the same evening, or on the return to base. I had some experience of the latter when riding with convoy leaders who could not afford the time I wanted for frequent halts, and I am sure that the results produced by plotting the map afterwards are inferior. Of course there is no reason why a second plot should not be made in the office after one's return, and this was actually done with all my work which lay in Sudan territory; but most of the original records of the work done in 1941 I had to leave in other

hands at Kufra, and they were subsequently lost. Nevertheless I believe firmly that only by plotting the traverse and detail intersected from it as one goes along can one hope in such a rapid reconnaissance to get the correct shapes of features, to capture something of the nature of the country, and to avoid errors of misidentification which may even result in a feature being shown twice. I would guess that the errors in the Italian maps came chiefly from their not being plotted in the field, but drawn afterwards in the office.

In my opinion therefore the survey should be plotted as it is made, and at the day's end the surveyor should have a complete plot of the day's work. This should be adjusted to the position of the camp, which must therefore be computed at once. Otherwise, should the surveyor on the morrow cross his tracks of the day before, he would have to contend with the probably larger discrepancy caused by the crossing of two unadjusted traverses, with the added difficulty that neither can be accepted. If, on the other hand, the previous day's traverse has been adjusted to a fixed point at each end, it can, as a first approximation, be accepted as completely accurate, and the new traverse can then be regarded as being responsible for the whole of the error, and so adjusted on the spot to cross the old traverse correctly. This simplifies considerably the problem of fitting new ideas of features to the plot already made of them from an entirely different angle, although it does not of course produce the best absolute position of the crossing point.

Thus I was driven inevitably to the final procedure adopted: firstly, plotting not only the traverse, but also all the detail survey as we went along; secondly, computing each astronomical fix as soon as it was made; and thirdly, adjusting and inking in the whole of the previous day's work as soon as the position of the camp was plotted. This adjustment was done by eye, after plotting by measurement about six points evenly distributed along the traverse; to have plotted the adjusted positions of every leg of the traverse would have taken too long. The route so obtained was then inked, and the detail adjusted to it by eye and inked in at once. The unadjusted plot of route and detail were then rubbed out, and that section of the map was complete, until I crossed a part of it on another day. Then, if necessary, some reshaping of the more distant detail would be done on the spot. In practice this computing and adjustment were only done in the evenings during the winter, when the shorter day prevented travel after about 5 p.m., and when the midday halt lasted only half an hour. In the summer, during which more than half of these surveys were done, it was impossible to use the sun-compass for about two hours near midday, and so we halted for at least that long, and gave both vehicles and men a necessary rest during the hottest part of the day. I would use this interval to compute the previous night's position and adjust the previous day's work to it, and thus save time in the evening. This delay caused no trouble as long as we did not cross the previous day's tracks before the midday halt.

Survey of detail

Since the work was all being plotted as it was surveyed, I used a plane-table and not a simple drawing board. The usual arrangement was to keep away from rough country or large hills, and drive on the flat plains, but I would

aim for any small hillock in the general direction of our route and stop the car beside it. A few minutes spent in taking the plane-table to the top of it were well repaid by the extra view obtained and the fact that one was raised above the mirage. The plane-table was orientated by various means: using a modified Cole sun-compass to get true north, sighting back along my tracks, sighting to some distant features previously fixed, or by the usual means with the magnetic compass. Of them all the last gave the most consistently reliable results.

Important features were usually fixed by compass bearings as well as by plane-table rays, since this provided data in the log for a possible future re-plotting of the survey. In areas near the convoy route where the innumerable tracks had softened the sand, it was impossible to stop the car without sticking badly, and the survey had to be carried out on the move. I had no form of hand sun-compass and found it best to get the driver to point the car at the object while I read off the compass and noted the speedometer reading. If one passed close to an object that reading as one passed gave a sufficient cross cut to a previously taken forward ray.

Some areas, if complicated and important, I would survey in the ordinary way with the plane-table, using two or three stations along the route. At the day's end this area could be moved bodily with the portion of the traverse in which these stations lay. Although we often covered over 100 miles a day in the first car, the distance actually made by the whole party would sometimes be only half this, for we would leave the lorry stationary at some points and go off on short branch traverses to survey small areas off the main route. In this way the main traverse, and consequently its closing error, would be reduced considerably in size. My average closing error was about 1 mile in 50, with the error about equally distributed between scale and azimuth.

General lay-out of traverses

It will be clear from the earlier general remarks that, even with these time-saving devices, it was still impossible to cover the ground completely, and the survey was actually built up from a fairly open network of traverses from which intervening features were intersected. The lay-out of these traverses was therefore of considerable importance, but it could not easily be planned in advance. The possibility of a sudden recall of the party, and the probable difficulty of getting another one together to continue work in the same area later both made it advisable to survey the most important features first, rather than work in full detail progressively from one side of the area to the other. As an extreme example of this uncertainty of plans I may quote the case of the southern Gilf Kebir, an important area of which I was anxious to make a really detailed survey. Five attempts were made in all, but every one was frustrated from one cause or another either before I started or during the first day or two.

Each day's traverse had to be arranged, so far as possible, to end at some feature which would be easily recognized and whose accurate position would therefore be of value; and there were on each map-sheet a few features which were not only recognizable, but were actually well-known landmarks already provided with names either by natives of the desert oases or by recent travel-

lers. One camp had to be pitched near each of these in order to provide an accurate fix for it.

These general principles were easy enough to formulate, and in conforming with them I was hampered only by the practical difficulties already described, apart from the usual unpredictable chances of desert travel, where on one day 200 miles may be covered, and on the next only 10. Harder to define are the principles governing the choice of routes so that they will give the maximum amount of information about the types of country in the different parts of the area. The importance of this information on a small-scale desert map is clear, for the characteristics of many features could only be shown on this scale by description. The best way to put this information on the map is to run a traverse along the boundary between two different types of country rather than wholly inside one of them, and this I always endeavoured to do. With some features, such as small areas of dunes, or mountains, or plateaux, this was easy enough; but often the boundary was an intangible line separating two areas which graded imperceptibly into each other, although they were quite different away from the boundary. Such areas were for example a dissected plateau, which still was recognizable as a plateau, and the broken hummocky ground into which its more eroded portion had degenerated; a series of rocky ridges with sand between, and gravel undulations separated by sandy patches; gravel sheet, and the sand sheet with only occasional gravel patches into which it often graded. The latter boundary is the only landmark over a large area west of Selima oasis.

It is almost essential to have some knowledge of geomorphology for this work, and some understanding of the processes of erosion and dune formation which are at work in a desert, without expecting the general rules to be obeyed in every case. The desert landscape practically always makes sense, and there are reasons for every form it takes, if one can only find them; with an understanding of them one can divide the desert into different topographical areas and describe and delineate each area; but without it the landscape seems to change from place to place quite haphazardly, and one is reduced to putting down only the obvious landmarks like dunes and mountains. A chance is then missed of showing on the map something which, though rather intangible, I yet believe to be of great value in rather rough maps of a small scale such as we were making.

In the larger areas of regular sand formations, such as the great chains of barchans or crescent dunes, and the long parallel lines of seif dunes, this form of mapping was particularly important; a single dune seldom formed a landmark because the main characteristic of these formations is the endless repetition of the same forms in any small area. Knowledge of dunes and of their structure has now reached such a point [1] that generalized descriptions are no longer sufficient, and more detailed and scientific ones must be given. There are now accepted symbols in use on most desert maps to show the two main types, the barchan and the seif, and information is required about the type, the direction of the crescents in barchans, and of the lines in seifs, whether the dunes are on the desert floor or on sand, and so forth.

[1] See in particular: R. A. Bagnold, 'The physics of blown sand and desert dunes.' London, 1941.

The use of cars among dunes is never easy, and it was necessary to get the maximum information from any traverse among them. One had to keep a sharp eye on the general dune form and note if it began to change, and then follow the boundary between the areas of different forms if the change were sufficiently striking. I have already given examples of these changes south of Tazerbo. Generally it seemed that the presumed up-wind and oldest side of the Rebiana Sand Sea was rather indefinite, with sandy undulations which gradually steepened until they broke and began to form proper seif lines with slip faces. The border region where this breaking began was obviously a useful landmark and therefore worth mapping. The down-wind side of the sea, on the other hand, was sharp, though irregular, and quite easy to define, with a number of dune lines stretching out over a gravel or rocky area like fingers; one or two would, for no apparent reason, extend several miles farther than most of the others. In the middle one would find that the orderly lines, across which travel was very difficult, might lose their order and give way to a chaos of dunes running in all directions and almost uncrossable, or they might fade out almost completely and allow free travel everywhere. Boundaries of such areas as these were clearly important.

In a chain of crescent dunes the form of the dunes may change both along the chain and also from one side to the other. Usually the dunes seem to adopt one of two main forms; either they are small and close together, with sandy cols between, or they are large and completely separated, with an area of flat sand or gravel forming good going between them. All these differences were worth noting and putting on the map.

As a result of the war a fair-sized area of the Libyan desert has been explored in considerable detail; it is doubtful whether maps of greater accuracy than these we produced will ever be worth while in the central desert. With them I consider that a party using cars properly equipped with a compass and speedometer could find its way about without difficulty, and that is as much as will be required.

Personally I have had the opportunity to see one of the most interesting areas on the Earth's surface, where there is literally not even a blade of grass for hundreds of miles, and where the only thing that moves, apart from oneself, is the drifting sand. This ultimate in deserts has its attraction undoubtedly, partly I think because it is an ultimate, and also because of its cleanliness and simplicity. The dust of the semi-desert regions around has been replaced by the heavier grains of sand which even in a high wind only flow along the ground; and finding one's way becomes a simple matter of geometry, uncomplicated by too faint or too many tracks or by unreliable guides. We learnt that it was possible, in a modern car fitted with desert tyres, to go almost anywhere in the desert except up a cliff or over the crest of a dune, and that one would never get lost as long as one depended solely on one's navigation.

THE PACIFIC THEATRE OF OPERATIONS

WILLIAM COURTENAY

Film Meeting, 5 February 1945

IT is a great honour to be asked by the Royal Geographical Society to deliver this lecture and, particularly, to have the opportunity of showing coloured films of some of the phases of the campaign in the south-west Pacific under General MacArthur and also the naval activities under Admiral Nimitz, in both of whose commands I have had the honour to serve during the last three years.

By the treacherous blow which the Japanese Navy struck at Pearl Harbour in the Hawaiian islands on 7 December 1941, the Japanese hoped to be able to spread so far across the Pacific that before the British Empire and United States forces could challenge their initiative they would, at least, have ensured that the homelands of Japan were out of range of our strategic bombers. That advantage was maintained until, in recent months, by the reoccupation of Guam, Tinian, and Saipan in the Marianas islands, we were able to establish bases for Super-Fortresses within range of Japan.

The extent to which the Japanese spread throughout the Pacific has not been appreciated in Great Britain, so long preoccupied by events nearer home. From Japan and Formosa they spread through China, Malaya, Singapore, the East Indies, New Guinea, the Bismarck archipelago, and the Admiralty islands; and they also spread through the Solomons. They possessed the Carolines under mandate and the Marianas, but they took Guam, which was United States territory. Farther east they possessed the Marshalls, but they spread into the Gilbert islands which were British, and threatened the Phoenix and Ellice islands farther south.

By 15 February 1942 the Japanese had taken Singapore. Four days later they were bombing Darwin from Timor island, the limit of their southern advance, only some 500 miles distant. By early March they had entered Lae and Salamaua on the north New Guinea coast and were attempting to cross to Port Moresby, to form a base for the invasion of Australia. They had mustered an army of about 250,000 for that invasion and at that time could easily have taken Darwin, for, with the British Navy engaged elsewhere and the U.S. Navy temporarily out of action, the seas lay open.

The Japanese did not take Darwin because it led only into the Australian bush. Nearly 1000 miles south of Darwin lies Alice Springs in the heart of Australia. Except for a light-gauge railway for the first 200 or 300 miles there was no communication except by bush track. Australian and American engineers were allowed ninety days in which to build a highway along this track for convoys carrying troops and equipment to defend Darwin, as it was not then possible to defend the town from the sea. That great highway was completed in eighty-eight days and is an outstanding engineering achievement of the war in the south-west Pacific. Along it since 1942 three great convoys have left Alice Springs each morning, carrying troops, equipment, and supplies over the 1000 miles to Darwin.

The Japanese objective was not so much Darwin as the Queensland coast. On the whole of the south coast of New Guinea there is only one port, Port Moresby, and this the Japanese required to assemble the forces they hoped to send across the Coral Sea, their intention being, first, to take Cape York peninsula, and then to move down the Queensland coast into New South Wales and Victoria, where the bulk of the population and the main industries are concentrated.

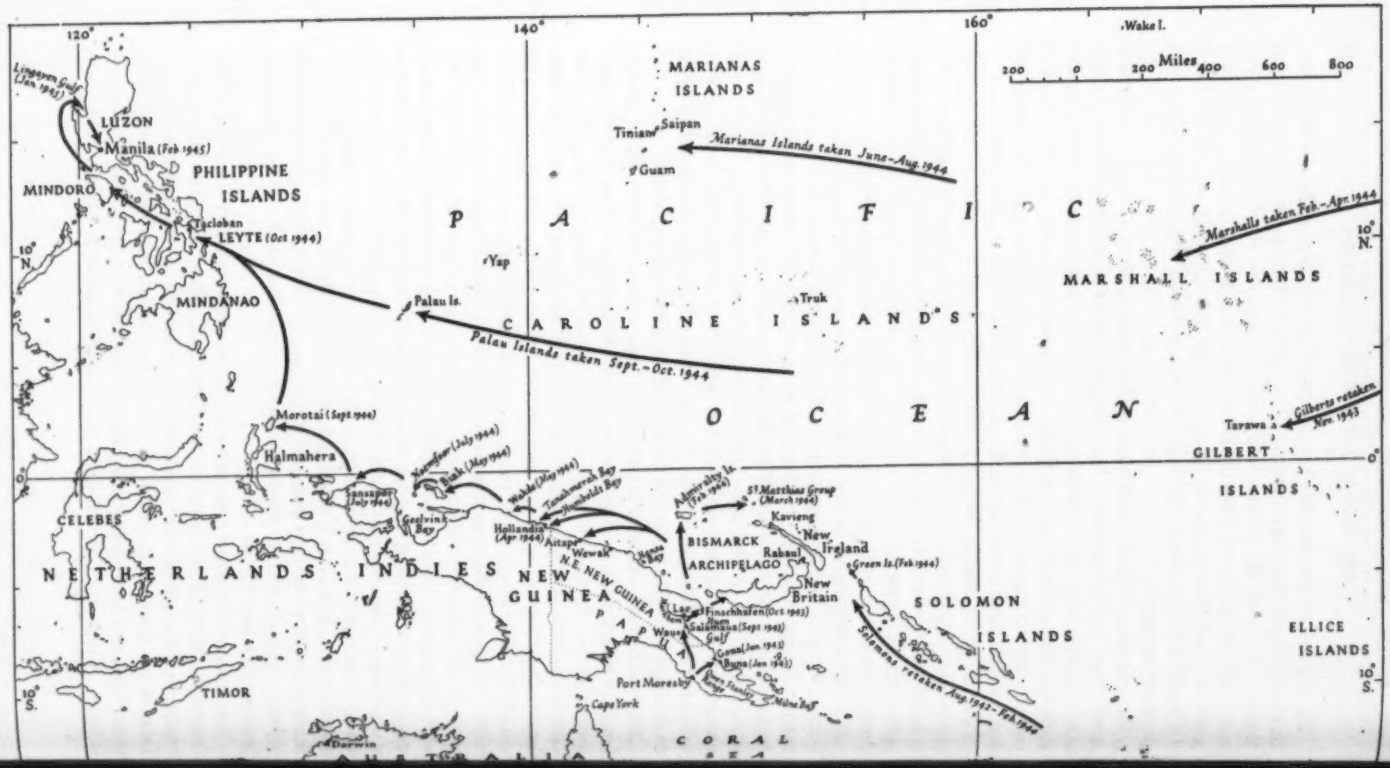
The retention of Port Moresby was thus vital to the Allies and its capture equally vital to the Japanese. They fought three distinct campaigns in 1942 with this objective. First, moving out of Lae and Salamaua through the Markham valley, they tried to find a route to the south, but were beaten, partly by the monsoon weather conditions, partly by the gallant effort of the then small Royal Australian Air Force and U.S. Army Air Corps.

Next came the battle in the Coral Sea in May 1942, when the enemy attempted to bring a fleet down from the Philippines, but it was intercepted by the airmen of the United States Navy. Many ships were sunk, troop transports discreetly retired, and Australia was definitely saved from invasion through the excellent work of the United States Navy Air Arm.

In July 1942 the Japs landed at Buna and Gona on the north coast of New Guinea, for the initiative on land still lay with them throughout the first months of 1942. Indeed, the limits of their expansion were not defined until August 1942, when the Australian Army was ready to seize the initiative, if only locally. The Allies' first land victory in the south-west Pacific was achieved on the east tip of Papua, at Milne Bay, where the Japanese also landed but were flung back into the sea by the Australian Militia who saved the airstrips and prevented the southern thrust extending farther.

Meanwhile the Japanese forces which had landed at Buna and Gona in July 1942 began to move over the mountain trails of the Owen Stanley range towards the south coast of Papua and Port Moresby. The critical period came about 20 September 1942, when the enemy reached a point some 20 miles from Port Moresby, with all the 7000-foot razorbacks safely crossed. It seemed that we would have to fight a perimeter defence, as we had done before. Then something strange happened. The Japanese were found dying on the mountain trails of dysentery, starvation, and food poisoning. They had not been taught to live off the jungle as had the Australian and United States troops. The initiative then passed to the Australian Infantry, two divisions of which had been brought from the Middle East. After a rapid course to convert them from desert warfare to its very opposite, jungle warfare, some of them moved into New Guinea and seized the initiative near Port Moresby. So began the long march which was to end on the north coast of New Guinea in January 1943, when a joint American and Australian force flung the Japanese back into the sea.

This change of fortune was entirely due to the novel and unorthodox use General MacArthur and General Sir Thomas Blamey, the Australian Commander, made of air power. We had few aircraft in the early months of 1942. The civil air-liners were taken off the air-routes in Australia, loaded with ammunition and flown 1500 miles from Brisbane over the Coral Sea to Port Moresby. There the ammunition was transferred to American and Aus-


120°
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MARIANAS ISLANDS
Tinian
Saipan
Marianas Islands taken June–Aug. 1944
Guam
LUZON
Manila (Feb 1945)
PHILIPPINE ISLANDS
MINDORO
Tacloban
LEYTE (Oct 1944)
10° N.
MINDANAO
Yap
Truk
Palau Is.
CAROLINE ISLANDS
Palau Islands taken Sept.–Oct. 1944
Marshalls taken Feb.–Apr. 1944
MARSHALL ISLANDS
Morotai (Sept 1944)
Halmahera
Tarawa
Gilberts retaken Nov. 1943
GILBERT ISLANDS
0°
CELEBES
Hollandia (Apr 1944)
Aitape
Wewak
NETHERLANDS INDIES
NEW GUINEA
NE NEW GUINEA
Finschhafen (Oct 1943)
Salamaua (Sept 1943)
Lae
Gona (Jan 1943)
Buna (Jan 1943)
Port Moresby
Milne Bay
Cape York
TIMOR
Darwin
10° S.
CORAL SEA
AUSTRALIA
BISMARCK ARCHIPELAGO
Rabaul
New Ireland
New Britain
St Matthias Group (March 1944)
Green Is. (Feb 1944)
SOLOMON ISLANDS
Solomons retaken Aug. 1943–Feb. 1944
ELLICE ISLANDS

tralian fighters to enable them to strafe the trail over which the Japanese were marching from Buna. The only trail on which they could possibly march was down in the creeks; we could not see them but we knew they were there. The lethal downpour of thirty thousand rounds each morning shattered their supply as they marched, while other aircraft shattered their ships as they tried to bring supplies from Rabaul, their G.H.Q. in New Britain, to Buna. The result was that the more the Japanese marched the more emasculated became their supply line and also the more vulnerable. They could neither protect their base at Buna nor their supply route across the sea and mountains. By 20 September 1942 they were halted near Port Moresby; by the unorthodox use of air power their supply route had been effectively destroyed.

Once the initiative passed to them, the Australian troops marched over the Owen Stanley mountains to the north coast of New Guinea. They were, of course, faced with the same problem as had confronted the Japanese : how to extend and protect their supply line over one solitary trail. Here again there was novel use of air power. Once more air transports were used to carry supplies while fighters kept command of the air over the battle area. Although the pilots were at times using aircraft inferior in some respects to the Japanese Zero, I did not see a single Zero over our lines during the march with the Australian forces over the mountains to the north New Guinea coast from September to December 1942. Our command of the air was absolute. The unarmed air-liner played a decisive role in increasing the tempo of the battle and, conversely, the lack of it contributed to the Japanese defection. To this the bulldozer, the grader, and the tractor also contributed, and the method of laying sections of runways from which aircraft can operate in all weathers throughout the year was decisive in jungle country. But the use of transport planes to supply our troops as they marched was only possible because here and there on some of the slopes of the 7000-foot ranges there were open patches of kunai or jungle-grass, about the size of a village green. The Army Service Corps laid these open patches out as supply-dropping areas. The few available Douglas transports flew down into the valleys, carrying out what would formerly have been regarded as impossible manoeuvres in country in which the machines were not designed to operate, and endeavoured to drop supplies on the small patches with most difficult approaches. There were then no parachutes to aid in the dropping of supplies, so that only blankets, ammunition, hard rations, and medical supplies could be brought over. Every man marching on the mountain trail had to carry on his back all he needed. A line of about one thousand five hundred native Papuans carried certain supplies, but they were not allowed a load of more than 40 lb. per man. The Australian soldier carried 70–90 lb. The gradients were sometimes 1 in 2, so that even mules could not be used. About 80 per cent. of the supplies dropped from the air in this unscientific manner were lost in the surrounding jungle. The 20 per cent. recovered succoured the line of supply as the men marched, while the air cover prevented the line from being harassed by the Japanese. Thus we succeeded where the enemy had failed, and gradually pushed him back over the mountains until he perished at the hands of a joint Australian and American force in January 1943 on the beaches on which he had landed so arrogantly in July 1942.

But hardly had the campaign to take Buna and Gona on the New Guinea coast ended in January 1943 than Generals MacArthur and Blamey were faced with another campaign of equal magnitude and significance. The Japanese had landed in March 1942 at Lae and Salamaua, and we had landed a few hundred Australian guerillas at a little airfield named Wau in the heart of New Guinea, the objects being to march along the mountain trails to harass the Japanese at Lae and Salamaua, to keep them contained there if possible, and to give them the impression that we were strong everywhere whereas, of course, we were painfully weak. In January 1943 the Japanese sent a regiment of three thousand three hundred marching after these troublesome Australians. The Australians had shot up so many of them in the towns that the Japanese put notices on the trees in the forests ordering them to surrender and warning them of the fate that would overtake them if they did not do so. But the cheery Australians took the notices off the trees, sent them home, and shot up the Japanese in Salamaua. The Japanese had reached a mountain overlooking the airfield at Wau and were marching down the last mile to take it, when General MacArthur rushed Australian troops from Port Moresby about 200 miles over the mountains up to Wau. They were put on the trails in company formation to guard the airstrip, with about eighty troops left to defend the airstrip itself. Then the Japanese discovered a mountain trail of which the Australians had no knowledge, so that three thousand of the enemy were marching on the airstrip with its eighty defenders. Two battalions of Australians were rushed up from Port Moresby. About January 21 bad weather settled over the route and all flying ceased. For seven days everything was immobilized, and the situation at Wau was deteriorating. When the weather cleared General MacArthur flew in one thousand two hundred troops in seventy aircraft; the next day the 25-pounder guns were flown in, and they saved the situation. Seven hundred and fifty Japanese were slaughtered at the edge of the airstrip on 30 January 1943.

That action marked the turn of the tide; the enemy fell back fighting all the way from Wau to Salamaua during the first eight months of 1943. By the middle of August the Australian and United States forces looked down on the sea again near Salamaua.

Throughout all these first eighteen months of the campaigns General MacArthur had no sea power, no amphibious equipment, no choice but to march over the mountain trails, his men suffering from malaria, dengue fever, and bush typhus. But by the summer of 1943 the first naval help and amphibious equipment arrived. Ambitious amphibious operations were then planned, which were to be characteristic of the remainder of the campaigns up to the fall of Manila on 4 February 1945.

When we halted near Salamaua in August 1943, General MacArthur planned a great operation to encircle the whole of the Huon Gulf by an enveloping movement and also a parachute operation. By this time the third of those famous three divisions of the Australian Imperial Force, the 9th Division, was home from the Middle East, and early in September 1943 that division began to move in barges, under the direction of the United States and Australian Navies, up the coast to above Lae, to cut the Japanese supply line. This was maintained by barges, because no Japanese ship of any size

could venture near Lae or Salamaua as a result of our growing command of the air over an ever-widening circle. Their barges came out of the Philippines, through the islands, down to the Dutch New Guinea coast, rested by day in the creeks, and at night sneaked along the coast to Lae and across the mouth of the Markham river to Salamaua. Therefore if the supply line to Lae was cut, Salamaua would automatically fall. The 9th Australian Division landed above Lae and, at the same time, an Australian force was landed at another jungle airstrip above Wau, called Tsili Tsili. They marched to the Markham river and on 3 September 1943 one thousand six hundred American paratroops, whom I accompanied, flew out of Port Moresby, up over the 10,000-foot Bismarck range to drop 400 feet into the Markham valley and seize another airstrip called Nadzab. Thus the whole area was enveloped: Lae and Salamaua fell by the middle of September, and Finschafen by early October 1943.

As a result of the operation General MacArthur was no longer bound to the mainland of Australia or to the island of New Guinea. He had burst the strategic fetters and was free to move out into the Pacific. His plan for 1944 was not to push forward along the coast, jumping into every little island and thereby prolonging the campaign for years, but to proceed by audacious leaps of 400 or 500 miles at a time; to find some base of importance on the westward march towards the goal, Manila, and to leap into that base where airstrips could be seized; then to jump over the enemy to some point to the limits of the tactical radius of the land-based fighter and to rely on carrier-borne aircraft. Hence by not attacking the Japanese where they expected to be attacked but jumping over them to some point where they were not expecting us, he achieved tactical surprise with each leap and left thousands of Japanese behind the lines, strategically impotent and unable either to escape because of our command of air and sea, or to receive help. Thus the jungle which the Japanese imagined was going to be their greatest ally was turned by General MacArthur into the most treacherous foe the enemy had then encountered.

It is satisfactory to be able to record that we have never failed to seize a beach-head on the day and hour appointed; nor have we yet been flung off the beaches we have seized. The Japanese have never been able to achieve any tactical surprise on land since Pearl Harbour, but have been continually out-manoeuvred and out-generalled.

The first of the great coordinated operations planned by Admiral Nimitz and General MacArthur in the central Pacific included the leap, made in February 1944 by the Texas Cavalry, from the north New Guinea coast into the Admiralty islands, about 300 miles north. The Admiralty islands, which are British, lay in the midst of a number of Japanese-held bases: Kavieng in New Ireland, Rabaul in New Britain, Wewak along the New Guinea coast, and Hollandia in Dutch New Guinea, only 400 miles away, while 750 miles to the north lay Truk, the great mystery Japanese naval base in the Caroline islands.

The United States Navy struck at the island of Truk at the end of January 1944, with such effect that we have not since heard of its use by the Japanese. No enemy bombers or fleet moved out of Truk to interfere with the operations of the United States Navy towards the end of February 1944. For weeks

before the landing on the Admiralty islands on February 29, American and Australian pilots bombed all the airstrips by day and by night so successfully that when we steamed through these waters not a single Japanese aircraft emerged from any of their airfields although they all lay within tactical radius of the Admiralty islands. The islands were taken by the Allies within a few weeks at the cost of the lives of about three hundred and fifty men in the Texas Cavalry, the Japanese losing six thousand dead. General MacArthur divined that now we had airstrips within one hour's flight of the Japanese G.H.Q. at Rabaul, Rabaul would become untenable and the enemy would move farther westward to a new G.H.Q. In fact they decided to move to Hollandia in Dutch New Guinea, a move General MacArthur forestalled by seizing Hollandia himself. The genius of General MacArthur has been his ability to divine the mind of the enemy, to take the correct action to forestall them, and to prove himself to have been right, which is the highest test of generalship.

We landed in Hollandia, after 1000 miles run, with a convoy of two hundred ships, on 22 April 1944, while the Admiralty campaign was just being completed. The Japanese had about three thousand troops at Hollandia, and General MacArthur induced the enemy, by many ruses, to send them all the way to Hansa Bay in barges, while we went in behind them, took Hollandia with its great harbour on Humboldt Bay and also three vital airstrips, with only fifty casualties. Thus thousands of the enemy were once more left behind our lines and the Australians are now dealing with them. With Humboldt Bay in our hands we had a harbour which the Japanese could not reach, and one which would play an important role in the Pacific campaign until the harbour at Manila was regained and Formosa reduced.

Throughout June, July, and August, 1944, further leaps were made into the islands in Geelvink Bay. Once Biak had been seized General MacArthur secured strategic control of the rest of Dutch New Guinea, so that the way was paved for the next advance. In each case the Japanese were completely out-manoeuvred. They believed that once we had reached the most westerly limits of Dutch New Guinea we would move into the Halmahera islands, so they put thirty thousand troops there but had only five hundred on the little island of Morotai to the north. General MacArthur took Morotai with only five casualties and left the thirty thousand on Halmahera, where they still are, thanks to our increasing command of the sea and the air. The thousands of Japanese left stranded behind the lines can play no further strategic role; they are however in tactical formations. They have their weapons and will shoot it out to the end, even though they know they are doomed. Before the native governments can be restored and the natives rehabilitated, the Japanese will have to be turned out, and already the Australians are carrying out that somewhat difficult task.

We took Morotai on 15 September 1944, an important date, because then we were only 350 miles south of Mindanao in the Philippines and within tactical air radius. On that same day Admiral Nimitz and the American Navy and Marines completed their long advance through the atolls and islands of the Pacific and, at the same hour, struck at the Palau islands, the westerly limits of the Caroline group, 550 miles east of the Philippines. That was the

result of the coordinated effort between Admiral Nimitz and General MacArthur. With the arrival of Admiral Nimitz's forces a junction was at last made between the forces of the central Pacific and those of the south-west Pacific. They formed one continuous battle-line, half encircling the Philippines, in readiness for the great blow which fell on Leyte on 20 October 1944.

In its great westerly advance across the Pacific, the United States Navy has been faced with a task without precedent in naval history. During centuries of naval warfare the Royal Navy has possessed bases and coaling stations throughout the oceans where the Navy has had to fight, so that ships have never been far from bases. Those bases, of course, have always been open to the United States Navy by reason of the gentlemen's agreement which exists between the admirals on both sides. But the Pacific, which was particularly an American area, was devoid of any base between Pearl Harbour and the Philippines. For nearly 5000 miles across the Pacific Admiral Nimitz had to operate without any permanent bases for his ships. He might have stopped at each group of islands, built a base and moved forward again, but that would have occupied about eight months each time and have diverted masses of men and equipment from duties elsewhere. The alternative was to take bases with him. That is what he did. A number of special repair ships were built in the United States to service each class of vessel: battleship, cruiser, aircraft carrier, destroyer, and submarine. Each special service ship cost as much and took as long to build as a battleship. They are floating workshops, moving with the fleet, and each carrying hundreds of skilled craftsmen. Thus a ship falling out of line can return to the appropriate repair ship a few hundred miles behind, to be re-conditioned and restored to the line. That was a magnificent achievement.

Only in November 1943 was the United States Navy able to take the initiative by striking in the Gilberts at Tarawa. Between November 1943 and September 1944 Hawaii was freed from risk of attack, the Gilbert and Ellice islands taken, and half the Marshalls—the half where the rain falls, the other half being left to the Japanese, so that they had to use submarines for supplies. The Caroline islands were by-passed and the Marianas taken. By 15 September 1944, the United States Navy had reached Palau, the same day as General MacArthur struck at Morotai. The great advance across the Pacific had ended.

That placed General MacArthur in a position to undertake the greatest adventure of all, the assault on Leyte in the Central Philippines on 20 October 1944. Once more the enemy were completely out-generalled. They thought that when we had reached Morotai we would move into Mindanao; instead, General MacArthur plunged into the centre of the Philippines, in spite of the fact that the Japanese had one hundred and twenty-five airfields in that area. By jumping into Leyte and obtaining one of the airstrips in the first few days the fighters were able to obtain some strategic control over Mindanao to the south and Luzon to the north. They had only to fly 250–300 miles each way from Leyte, carrying bombs. Thus we were able to maintain control in spite of the Japanese having still one hundred and twenty-four airstrips. At Leyte the Japanese lost one hundred and twenty thousand men between October 20

and December 20, and twenty-four destroyers and seventy transports, apart from other losses in the battles at sea off the Philippines. It was a great satisfaction to land with General MacArthur, in fulfilment of his pledge to return to the Philippines, and to see the enthusiastic reception accorded to him. The success of the campaign was due to the brilliance of General MacArthur's strategic conception. The decision to increase the tempo of the battle and to make the leaps from base to base was his. That audacity yielded high dividends for the campaign has been carried out at the cost of comparatively little loss of life among the American and Australian troops.

But another problem of a different character had to be solved. Hundreds of Filipinos came into our lines even while the battle was being waged. While arrangements had been made beforehand to deal with this eventuality, no one expected that thousands of Filipinos would risk crossing the lines on D Day. The airstrip at Tacloban was taken on D Day plus 1, October 21. At Tacloban, the largest city on the island of Leyte, the proclamation was read to the Filipinos promising them their independence, which had previously been promised to them by 4 July 1946. By that date, despite the war, the Filipinos will be free, with aerodromes and naval bases safely in American hands, to protect them from aggression.

From Leyte General MacArthur made his most audacious move, through waters in which the Japanese air-arm should have been able to strike at our ships, to land on Mindoro on the flank of the island of Luzon. On 6 January 1945, he was able to land on the Lingayen Gulf for the march to Manila, which brought him to his goal within twenty-seven days of the first landing at Luzon. Thus ended three years' operations which, throughout, demonstrated the vital role which air power, operating from aircraft carriers or land, can play.

DISCUSSION

Before the lecture the PRESIDENT (The Rt. Hon. Sir GEORGE CLERK) said: This afternoon we are to have the pleasure of hearing Mr. William Courtenay on the campaigns in the Pacific and of seeing some of the colour films of New Guinea and the Philippines which he has brought back with him. Mr. Courtenay has been with General MacArthur's headquarters from the commencement of the operations as war correspondent of the *Daily Sketch* and Kemsley Newspapers. His lecture to us is most timely, following as closely as it does on the fall of Manila. We look forward with the greatest interest to his address, and as he has much to show I ask him to begin without further delay.

Mr. Courtenay then delivered the lecture printed above.

The PRESIDENT: I am sure you all agree that we have had an afternoon such as we have rarely the good fortune to enjoy. I find it difficult to express what you all feel about the lecture to which we have listened. In describing a campaign which was carried out many thousands of miles from our shores the lecturer has brought home to us days of hard work, courage, skill, strategy, so that now we can appreciate the amazing task that the American and Australian forces have carried out. I ask you to express to Mr. Courtenay our warmest thanks for the lecture he has given us

SOIL EROSION IN AUSTRALIA

MICHAEL TERRY

This paper is a summary of an account submitted by Mr. Michael Terry, who obtained the information on visits to research stations and Soil Conservation Boards in Australia and from recent publications. The pamphlets, whose titles are given at the end of the paper, have been presented by him to the Library. —ED. *G.J.*

New South Wales

NEW SOUTH WALES, the birthplace of Australian settlement and agriculture, suffers from widespread soil erosion both in the farming areas and in the western grazing areas. To control this, the Soil Conservation Service (Director, Mr. E. E. Clayton) was established early in 1938, and has now begun work throughout the State. Observations have been made in the catchment areas of the Hume reservoir (Murray river), the Burrenjuck dam (Murrumbidgee), Wyangala dam (Lachlan), the Snowy river catchment, the Keepit catchment (near Tamworth), and the Warragamba catchment (between Goulburn and Wallerawang) which encloses an additional water supply for Sydney. Run-off has been surveyed as in the United States. Cooperation is being established with the group farms where poor tillage is increasing the silting up of State water supplies. And throughout a close liaison is maintained with Dr. Hugh H. Bennett, of the United States Soil Conservation Service.

The New South Wales Service receives annual grants of about £45,000, but this total will soon be greatly increased. Even then men, machines, and supplies will be hard to obtain until difficulties due to the war are resolved, and the work proposed for the Service, as for its counterparts in other States, will be restricted.

Between 1940 and 1944 the whole State was surveyed for erosion control. In the Western Division, containing 125,498 square miles out of the 309,431 square miles of the State, 70 per cent. of the land is visibly affected by wind erosion. In this region the survey concentrated on the vegetation cover. The incidence of dominant timbers, such as mulga, belah, rosewood, mallee, and coolabah was mapped; the areas of saltbush, bluebush, and grass were determined, and degeneration due to stock-raising was noted. The combined effect of stock, rabbits, droughts, and erosion has been so severe that in the worst areas from 20 to 90 per cent. of the mulga trees have been killed. When the report on this work has been studied vegetation cover will be related more closely to the optimum all-season carrying capacities of the various grades of pasture. Authority exists in law to enforce carrying capacities, but so far they have been applied by cooperation.

In the Eastern and Central Divisions (east of a line about 300 miles inland from Balranald to Mungundi), another type of survey has been made during the two-year period 1941–43. Five officers, with local assistance, have classified the types of erosion in ninety-eight counties. Working in pairs, and travelling by car, they surveyed a county a week. They started with a State

map ruled into 2-mile squares, on which they marked the different categories of soil erosion, but adjusted these arbitrary boundaries in the field to suit local divisions. Notes, including a report on each county, are now in the Head Office of the Service, but until plotting is finished final figures are not available. A first study reveals the following position for these two divisions:

	Coastal [1]	*Tableland*	*Slopes*	*Plains*
Bad and seriously gullied ..	0·7%	0·6%	0·9%	0·1%
Shallow gullies and Bottom lands badly gullied ..	10·3	31·6	32·0	1·4
Sheet erosion	21·8	26·3	25·3	12·7
Minor wind erosion	—	—	3·4	26·5
Severe wind erosion	—	—	0·2	1·5
No appreciable erosion [2] ..	67·2	41·5	38·2	57·8

[1] Includes the Hunter river valley.
[2] Includes timberlands without settlement.

Nearly half the area of these districts is affected by some form of erosion, as the following figures show:

Seriously eroded	882 square miles
Medium gullying (which may be saved) ..	29,670
Sheet eroded	32,400
Wind eroded	7,500
Relatively unaffected	80,000

The worst areas are the Hunter river valley, particularly near Singleton and Muswellbrook, and the north-west slopes, bounded by Tamworth, Manilla, Barraba, Bingara, and Inverell. To dredge Newcastle harbour, at the mouth of the Hunter river, now costs as much as £60,000 per annum principally as a result of erosion in the river valley. In the Forestry Commission Report, the devastation of this valley is described as "One of the major tragedies in the history of land settlement in New South Wales. . . . To-day, eighty-three years after the first ringbarking for grazing improvement . . . and sixty years since this work had destroyed most of the forest cover on threequarters of the purchased land, besides a considerable area of Crown Lands in the Valley (which practice still continues), a scene of rural desolation remains." The Report states that the badly affected areas should be reclaimed by a forest cover on about 10 per cent. of the area, involving treatment of about 100,000 acres. The introduction of Texan flora is suggested, as the climate of the valley is similar though less extreme than that of Texas. The two Shinnery Oaks (*Quercus breviloba* and *Q. Harvadi*) are suitable for general planting, and *Ehretia elliptica* for large gutters and gullies. Planting a strip two chains wide outwards from the top of the flood bank is recommended along main streams, using softwoods such as willow, poplar, New South Wales river oak, and two Texan poplars (*Populus angustifolia* and *P. tremuloides*).

Erosion control forests are also needed in the catchments of the Murray river above Hume weir, the Murrumbidgee above Burrenjuck, and the Lachlan above the Wyangala dam.

In the Western Division at present there are no State Forests; at least

10 per cent. of the area should be forest. As the climate of this region resembles that of Palestine, Egypt, or Arizona, its rehabilitation will not be easy. However striking changes can be made. At Broken Hill the example of the Zinc Corporation in planting trees around its mine was soon followed both within the town and on about 3¼ square miles of eroded ground fenced off for the purpose outside. To-day a tree and shrub belt from ¼ to ½ a mile wide surrounds the town. Eighteen varieties of eucalyptus, thirteen wattles, and many indigenous and exotic species have been established in a very short time. The most outstanding have been the cuttings of tamarisk (*Tamarix aphylla*), imported from California as recently as June 1936, which besides providing hundreds of cuttings for further planting, have grown into trees 30 feet high. Red gums (*Eucalyptus camaldulensis* and *E. intertexta*) have in five years grown to 20 feet in height. Except that the reserves were fenced to exclude stock and rabbits, no artificial aids were used to conserve the soil. It has been disappointing how slowly the perennial herbage has regenerated.

A year after it was formed the New South Wales Soil Conservation Service opened an experimental station of 250 acres at Cowra, 200 miles west of Sydney. Well equipped and with its own meteorological station it is still the only one in Australia. Similar stations are being developed at Wagga Wagga (550 acres), Wellington (377 acres), Gunnedah (498 acres), and Inverell (300 acres) to study and to apply local erosion control measures, so that new ideas will be brought into land use, management, and reafforestation. The experiments are intended ultimately to determine whether the native flora, with its valuable property of feeding stock after grasses have died, should be re-established, or whether new species which, if unable to feed stock, establish themselves more rapidly, should be introduced.

Coastal sand dunes near Port Kembla, on the southern part of the coast, have been stabilized first with Marram grass, then with couch and buffalo grasses. Staking is necessary in especially bad areas. Sandhills on the northern coast, where encroachment threatens sugar cane farms, have also received attention.

Queensland

In 1935 the Department of Agriculture, Brisbane, started to demonstrate control measures. Broad-base terraces were constructed on the Darling Downs. Shortly before the 1939 war, Mr. F. Skinner took charge of a sub-department for soil conservation. He made more experiments on the Darling Downs, and also at South Burnett, and on the Atherton tableland. Soon after the start of the war he joined up and subsequent work has been seriously handicapped by shortages of labour, machinery, and staff. It is proposed to divert earth-moving machinery, used in Queensland by the Allied Works Council for war construction, to post-war erosion control.

In 1943 the Land Act was amended to prevent timber being cut on the banks of rivers and streams on freehold and Crown Lands.

South Australia

In 1936 Commonwealth and South Australian State Ministers conferred in Adelaide; as a result of a Committee's report published in 1938, the Soil

Conservation Act of South Australia was passed in 1939, and amended in 1943. Perhaps the most important section is that empowering the Commissioner of Crown Lands to order herds to be reduced when the Pastoral Board reports that the natural cover is being damaged. In practice this has been arranged so far by cooperation with lessees.

A Soil Conservation Service, under Mr. R. I. Herriot, has recently been formed, but field experiments have been going on since 1937, when the Waite Institute planted numerous native and introduced species of herbage for observation at Pallamana. The adaptability of the native saltbushes and bluebushes was clearly demonstrated as well as their dominance over the introduced species.

In 1939 at Pallamana the Institute began to investigate better ways of using marginal crop lands by means of a long-term crop rotation. The experiment covers 7 acres and includes sixty-four plots in eight rotations. Elsewhere in 1939, saltbushes, bluebushes, and other species were artificially seeded under favourable conditions, but without success. The regeneration of mulga (*Acacia aneura*) has however been shown to occur on over-grazed areas protected from sheep and rabbits. And where the soil moisture was augmented by contour ploughing on a denuded slope at Blanchetown, the seeding of saltbush, bluebush, barrel medic (*Medicago tribuloides*), and Wimmera rye-grass was successful.

On the Yudnapinna station in 1941 the Waite Institute divided 5 square miles of bluebush and myall (*Acacia Sowdenii*) into fourteen plots of 160 acres each, with two large reserves in addition. The object was to find how shrub steppe reacted to differing degrees of grazing, and to examine the preservation and economic use of pasture in low rainfall areas. Four types of spelling, or resting, treatment were employed at grazing intensities of twenty-four, forty-eight, and seventy-two sheep per square mile. Once a year herbage weight is estimated at sixty-four fixed points, and every month sheep are weighed and wool production recorded after shearing. Sufficient feed has always been available in spite of droughts, and no significant changes have occurred in the live weights of the flock or in wool production up to 1942. In August 1942 there was a difference in only one plot where seventy-two sheep per square mile had grazed for thirteen months continuously. In this plot the bluebush was severely overgrazed. The experiment however is a long term one and is not expected to yield major differences immediately.

In 1941 the Soils Division (Council for Scientific and Industrial Research) and the State Department of Agriculture cooperated to survey the eastern half of Victoria county. The data collected were marked on aerial photographs in the field. In the Hundred of Belalie some 35 per cent. is permanently grazed, the rest almost entirely under wheat generally on a two-year wheat–fallow rotation. Conditions now favour rapid run-off because the pastures have been generally overgrazed and nearly all cultivated land lies bare or in stubble during the summer. The delicately balanced drainage system has been upset and is thus probably typical of large areas of wheat-growing country throughout southern Australia. Recommendations include grazing under strict control, a period under pasture, and growing lucerne where possible between wheat crops.

Phot. N.S.W. Soil Service

Stock reserve, Condoblin: checkerboard furrows

Phot. N.S.W. Soil Service

Stock reserve, Condoblin: oats put in with scarifier and stubble not removed

Phot. Vic. S.C. Board

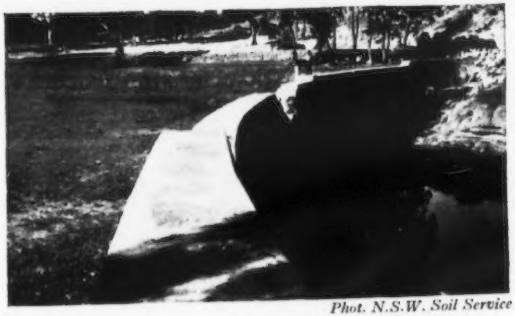
The Mallee: partly denuded land furrowed to trap topsoil

Phot. Vic. S.C. Board

The Mallee: limestone exposed by wind ***erosion***

Phot. N.S.W. Soil Service

Windramingle: hummocking, final stage of erosion



Phot. N.S.W. Soil Service

Werris Creek, near Hunter river: dam silted up

Phot. N.S.W. Soil Service

Western Division, N.S.W.: roots of ***mulga exposed by wind erosion***

Since the later 'twenties wind erosion in The Mallee has been studied and as received considerable publicity. Progress has now been made in readjusting agricultural practice through Commonwealth funds made available to the Marginal Lands Committee. Widespread use of cereal rye and sand-binding grasses such as Pyp grass (*Ehrharta villosa*) and Marram grass is effectively stabilizing sand dunes.

In the last three years water erosion has received much attention because it has been developing acutely in the best agricultural lands. As farmers are now aware of the danger, effective control should soon be possible.

Western Australia

In Western Australia the official view seems to be that soil erosion is a minor concern. This may be due to a more recent agricultural history and thus less disturbance of the natural cover.

Tasmania

There is good reason to believe that parts of Tasmania have been considerably eroded. Inspections are in progress but no reports are to hand, nor, so far as can be discovered, have corrective measures been applied.

Victoria

In Victoria sand drift was noted in The Mallee as far back as the 'seventies. Several rivers began to erode during severe floods in the 'nineties, but the collection of information on the subject was not begun until 1917. In 1925 the River Murray Commission asked for action to prevent forest destruction in the Hume catchment. In 1933 a Committee reported on wind erosion in the newer Mallee, which was then becoming accentuated. Following the 1936 Adelaide Ministerial Conference, a Committee was appointed to examine erosion in Victoria and then, in December 1940, the Soil Conservation Board was formed.

So far there has been no state-wide investigation: enlistment of officers and other war work has prevented this. Nevertheless a general outline is being obtained of the distribution and intensity of the various types of erosion.

Although boundaries are not well defined, generally wind erosion is more serious where rainfall is 15 inches a year or less, as in the north-west part of the State. Here in one of the most important wheat areas, rain is light and unreliable. Thus the counties of Millewa, Weeah, Karkarooc, and Tatchera, with the north of Lowan, and Borung (*i.e.* The Mallee and northern Wimmera) are the main wind erosion areas. The Soil Conservation Board recommends that for maximum control of erosion in light Mallee country the smallest one-man farm should be 1200–1300 acres, in heavier Mallee country, 900 acres. Stubble should not be burnt but the straw retained for soil binding.

Water erosion affects more than half Victoria. Sheet erosion and gullying are marked on the northern slopes of the Divide, which have a hot dry summer with occasional torrential summer and autumn rains; the average rainfall is some 15–35 inches. The area is bounded by Corryong, Beechworth, the

Warby and Strathbogie ranges, Mansfield, Seymour, Kilmore, Castlemain, Avoca, and Stawell. It includes timbered and cleared grazing areas as well as important cultivation areas on the foothill slopes north of Benalla, in the Dookie hills, and in the St. Arnaud–Charlton–Korong Vale district. South of the Divide sheet erosion is less marked but there is considerable gullying and some landslides in the Glenelg valley between Casterton and Balmoral. Sheet erosion and gullying are important in the vicinity of Ararat, Beaufort, and Rokewood in the Western District; to the east of Ballan through Bacchus Marsh to Sunbury and Whittlesea; and in the eastern Upper Tambo and Omeo districts. Some gullying occurs in drier Gippsland, notably around Heyfield, Rosedale, and Bairnsdale.

Thousands of acres of good river flats have been scoured out by stream erosion on many of the faster-flowing rivers: notably the Avon, Mitchell, and Tambo rivers in Gippsland, and by the Upper Murray, Mitta, King, Ovens, and Goulburn rivers in the north-east. The beds of some rivers, including parts of the Glenelg, Tambo, and Snowy rivers have become mainly filled with silt and sand. Erosion debris has almost choked bridges on Bullock Creek north of Marong, and streams north of Casterton, Eaglehawk Creek in Gippsland, and others flowing north-west from the Strathbogie ranges. The Laanecoorie reservoir, on the Loddon, is more than half silted up, and there is certainly some silting in the larger Hume and Eildon reservoirs, though little of their capacity has yet been lost. Following bush fires in 1939, in one year silt totalling 1000 acre feet (3 per cent. of the storage) was deposited in the Eildon reservoir.

A peculiar phenomenon, even in hilly districts and where surface drainage seems to be adequate, is the development of undue salinity in large patches of soil. Fertility is ruined and surface vegetation is killed, resulting in severe erosion.

The Department of Agriculture Mallee Research Station at Walpeup, has experimented for some years with the control of wind erosion and sand drift. It has gathered much valuable information on freedom from erosion and drift for wheat farming in semi-arid areas. The Country Roads Board has studied how to prevent damage to roads by gullying. The State Rivers and Water Supply Commission has begun erosion control, notably on the Lerderderg and Werribee rivers at Bacchus Marsh, the Avon at Stratford, and the Murray at Wodonga. Early in the history of the State the Crown reserved widths from 3 chains beside major rivers to ½ chain beside minor creeks for stream maintenance and bank protection. Cover can only be removed from these reservations under authority though they are often leased with strict conditions. The revenue, about £9000 a year, is used for "snagging" stream beds, revetting banks, and other erosion control.

Other research is proceeding, such as an ecological survey of the Victorian part of the Hume Catchment area, by Miss Fawcett, and a pasture survey in the Omeo–Hinnomunjie area. Regional advisory committees reporting to the Soil Conservation Board have arranged demonstration areas in The Mallee, Hume Catchment, and other areas, while competitions, such as the Hanslow cup, are held for the most successful use of methods of conserving soil and preventing erosion.

The Dookie Agricultural College has experimented with the safe disposal of storm-water in order to slow down the run-off, resulting from the farming methods employed, which has done such damage to more than half Victoria. In 1939 it began to treat gullies with wire-netting checks which cause considerable deposition of silt. Contour ploughing, started in 1940, proved most successful. In comparable districts with about 21 inches of rainfall this method is advised; the cost worked out at about 8*s*. per acre. Furrow spacings were: on a 20 per cent. slope at 4-foot vertical and 20-foot horizontal distances; on a 10 per cent. slope at 3-foot vertical and 30-foot horizontal distances. Heads of gullies have been plugged with bags filled with soil, the surface being covered with bags in which grass seed was mixed. Other gullies have been ploughed when they became stabilized.

North-eastern South Australia and south-western Queensland

This must be one of the most seriously eroded areas in Australia. Between August and December 1935, and again in 1936, the Council for Scientific and Industrial Research sent Mr. Ratcliffe to report on these two areas. In South Australia there was a drought towards the end of a run of dry seasons unique in local experience. This region, which is now devoted almost exclusively to sheep, receives less than 10 inches of rain a year, most of it variable and frequently in light and ineffective showers. In the segment of Queensland covered by the survey, except for properties near Windorah and others carrying sheep and cattle near the South Australia border, it is cattle country. Rainfall was little more reliable or heavier, but there were marked contrasts between the two regions.

The more important conclusions in Ratcliffe's report are: Soil especially liable to erosion is comparatively absent from the south-west corner of Queensland, unlike the South Australia semi-desert. The drift in Queensland possesses a relatively luxuriant growth of plants although it has been unstable during long droughts, and there is abundant seed ready to respond to rain. In South Australia the drifts are sterile, being derived from sandy soil which has not yet acquired a flora suited to a pure sand habitat; given some good seasons and sufficient time these younger drifts should become fertile.

Contrary to popular reports in the press, sand from the Central Desert is not encroaching upon and ruining valuable and fertile country to the east and south. Desert certainly is spreading south-east in South Australia and possibly north-west in New South Wales, but this is because stock and rabbits have reduced the marginal semi-desert areas to unproductivity during droughts: the resultant drift, even where sufficient to form dunes, is a local product.

Except for minor changes the Queensland sandhills are stable. Even if all vegetation disappeared the change would probably not be great because "an equilibrium has been established between the sand material and the winds."

The north-eastern part of South Australia is principally saltbush steppe and acacia semi-desert or mulga scrub. The steppe is covered by low-growing perennial shrubs. Rabbits are often blamed for the serious drift in these regions, but it is said "Saltbush kills far more rabbits than rabbits kill salt-

bush" for although rabbits may nibble the plants in droughts, the salt increases their thirst and they rarely kill the plants. The principal damage done by rabbits is that in eating out the annuals they force the sheep to turn earlier to saltbush. In general it seems that overstocking is the real cause of the drift.

In much of this area of South Australia the full extent of the damage has yet to occur. During the twelve to fourteen years before 1935 when rain failed for season after season, most of the perennial bush was killed. Much of the semi-desert, although injured beyond hope of recovery is still holding together. Eventually the dead and dying plants will break up and be destroyed. If annuals return in a sequence of good seasons the final stage of erosion will only be postponed unless stocking policy is radically altered. It is rare to see even a small area without dead or dying trees, and the seedlings, much sought after by stock and rabbits, have no chance to mature. Twenty-five sheep to the square mile, even at the worst periods, does not harm the saltbush steppe provided that there are sufficiently large paddocks and decentralized waters.

In considering measures to assist recovery in these areas it should be appreciated that the unimproved capital value of most of the land is less than 2*s* per acre. As distance from railway increases and rainfall decreases, the land becomes practically valueless. Plough-furrowing at right angles to the main sand movement has materially checked drift in some parts, but it is quite uneconomic for much of this land. If stock were excluded the original saltbush cover would regenerate, but this would take decades, even centuries. In fourteen years saltbush advanced only 400 yards inside the fence of a bush-less paddock from an adjoining paddock of healthy saltbush on a property in the north-east of South Australia. The local Spear grass (*Stipa nitida*) and Biridy-i (*Bassia spp.*) seem most likely to provide some sort of cover for denuded areas in this district. Sagebush (*Sida corrugata*) is sufficiently hardy to establish itself and is being increasingly used. Professor J. G. Wood has experimented with introduced plants but without success. The conclusion is that in the devastated parts of South Australia introduced plants will not succeed where native species have failed.

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THE GEOLOGY OF FRENCH WEST AFRICA

ESQUISSE GEOLOGIQUE DE L'AFRIQUE OCCIDENTALE FRANçaise. By P. LEGOUX. Bulletin No. 4, Service des Mines, Gouvernement Général de l'Afrique Occidentale Française. *Dakar: Grande Imprimerie Africaine*, 1939. 11×8½ *inches;* vi+134 *pages; sketch-maps and diagrams, and* 1/5*M coloured map*

THIS official publication, which reached the Society in 1944, is valuable to students of African geology because it gives a balanced view of the vast and varied territories between Mauritania, Chad, and the Gulf of Guinea, and of their mineral resources: in the reviewer's opinion it is also essential to any study of the geography of those parts. It is divided into Part I, General Geology, and Part II, Applied Geology, or mineral resources. The coloured map (1/5M), with insets of structure and tectonics and of documentary information, includes territories other than French, although only a small part of Nigeria is shown.

The memoir is prefaced by some remarks by M. P. Seyer, Chef du Service, in which the long and arduous investigations since the beginning of the century are tersely described; they contain some very useful information, difficult to get from other sources.

As African geologists well know, there are some thorny problems in the region, and M. Legoux is to be congratulated on the manner in which he has dealt with them. He emphasizes that his synthesis is based on compilation and consultation of published and unpublished material of authors and professional colleagues in his own and other surveys (including British): he has certainly handled his information in masterly fashion.

On the map a single colour is used for the granites, ortho- and para-gneisses of the "Granito-gneiss," and another for the "schistes et quartzites redressés," or Birrimian of the Gold Coast, with symbols to distinguish the various metamorphic series and phyllitic rocks. The Birrimian and Granito-gneiss are shown thereby to extend probably from Mauritania to French Guinea and thence to the Gold Coast: the Birrimian is not shown in the interior massif of the Adrar des Iforas, though it seems to be identified in Aïr: it is mapped with the Granito-gneiss both north and south of the Niger between Timbuctu and Niamey, and in Dahomey. The Granito-gneiss appears, of course, in all the interior massifs and in Nigeria.

The Granito-gneiss and the Birrimian thus form shields, which go by various names but are basically no more than elevated and exposed parts of the African continental platform. In them trend lines, broadly termed "Huronian," are

recognized to run generally north–south, with many local variants: the foldi... is strong and the rocks are highly metamor...

Various sediments which are usually gently folded and slightly or not at a... metamorphosed are considered to be of Pre-Cambrian age; some of them l... unconformably upon the shield-rocks, with basal conglomerates. They a... differently named in the various territories and no contemporaneity is nece... sarily suggested: grouped together as the Intermediate Folded Series, they a... mapped by a single colour with symbols and letters to distinguish the ind... vidual groups. Thus the Falémé System is traced from Mauritania to Fren... Guinea and continued by the Rockell Series in Sierra Leone; in the Go... Coast is the Tarkwaien, with its gold-bearing conglomerates. In the easte... Gold Coast, Togo, and Dahomey, from Accra to the Niger between Niam... and Gaya, lies the Atacora chain, consisting for the most part of moderate... folded sediments, known to British geologists as the Akwapimian and perha... divisible into the Togo-Atacora and Buem Systems of other authors. So... interesting sediments on the Niger about midway between Bourem and Niam... are now also grouped with the Intermediate Folded Series, which otherwise ... not identified in the vast interior of the French Sudan, Niger, and Sahar... territories.

It will probably be agreed that the above scheme is useful and satisfacto... for all general purposes that the map is intended to serve; in the text M. Legou... makes ample reservation for the many difficulties and unsolved problems of ... rocks older than the Palaeozoic. Although there is a superficial resemblance ... the 1/6M geological map of the Atlas des Colonies Françaises (1934), all t... rock-groups so far enumerated have in fact undergone reclassification and be... plotted afresh with valuable results: for general purposes the older map mu... be considered obsolete.

M. Legoux's synthesis of the Palaeozoic stratigraphy is extremely interesti... and space alone forbids a much fuller treatment of it in this review. The sed... ments are mustered on the map in two groups, each with its own set of symbol... one for French West Africa, excluding the Niger Colony, the other for that colo... and adjacent territories on the east and north. The method represents a d... parture from earlier practice (for example, the 1934 map) and produces interes... ing results, enhanced by the structural map which shows north-east–south-we... Hercynian anticlines and synclines (Hercynian being used in the widest sense

The stratigraphical arrangement hitherto adopted has been broadly ... follows: In the north a Cambro-Silurian group, including possible Cambri... followed by Ordovician and later beds known by fossils, from the Atlantic co... over Mauritania, Rio de Oro, western Morocco, and the Sahara, passing fro... marine to continental beds in that direction. In the south the Horizontal San... stones, divisible into basal conglomerates; dolomites and other beds; a... uppermost thick and prominent cross-bedded sandstones, of presumed b... undefined Palaeozoic age owing to the lack of fossils.

There is now sufficient evidence to adopt common symbols: a developme... forecast by the Carte géologique internationale de l'Afrique (sheet 1), 1/6 M... 1936. Beds of Cambrian or Cambro-Ordovician age are therefore recognize... from Rio de Oro north-eastward along the northern and southern flanks of th... Eglab (El Hank) anticline towards the Saoura and southward to the Senega... river, thence eastward, where they form most of the great Affolé anticline... Patches are also mapped south of the Niger bend, north of the Gondo plai... The overlying Ordovician (?) sandstones include the beds in the synclines o... Tindouf, between the Eglab anticline and the Anti-Atlas, and of Taoudeni... between the Eglab and Affolé anticlines; to them are added the upper sand...

one group from Senegal to the Gold Coast, that is, between the Affolé anticline and the shield rocks of Bandiagara; and in the Volta syncline.

It is thus shown that the Ordovician sea transgressed not only eastward, as already known, but southward so that the series is incomplete in that direction, the Cambrian being absent in Guinea and the Gold Coast, *i.e.* south of 13° or 14° N. The cross-bedded sandstones there may be in part analogous to the Tassili sandstones of the Ahaggar–Fezzan–Tibesti regions, to which reference is made below. There was marked post-Ordovician regression. The Tindouf, Taoudeni, and Tanga synclines in the western Sahara contain fossiliferous marine Silurian (with Gothlandian graptolites) and Devonian beds, a comprehensive Lower Palaeozoic sequence thus being identified. Carboniferous strata are also known especially in the Taoudeni syncline, and there are separately mapped marine Dinantian and continental Westphalian groups.

The deduction and method of mapping are logical both stratigraphically and structurally and they show a material advance in the last decade; they give cohesion to some of the broader views of African geology.

To the above must now be added the separate arrangement for the Niger Colony and adjacent territories of the interior massifs (Adrar des Iforas–Ahaggar–Aïr–Tibesti), for beds which are in fact mainly exposed in the Tassili escarpments) surrounding the elevated shield rocks. They comprise the Silurian of the Tassili, marginal deposits of the transgressive and regressive Lower Palaeozoic sea, largely sandstones, also partly continental Devonian and Dinantian and continental post-Tassilian, *i.e.* post-Dinantian continental beds of as yet ill-defined age. The groundwork of the mapping had been brought up to date in Kilian's 1/4 M map of the French Sahara east of 6° (1936) and in the draft of sheet 2 of the International map (1937).

This arrangement is well known and in use in the regions which it concerns, but the separation on the map of the dominantly marine beds of the west from the Silurian of the Tassili is a departure from the policy which seemed satisfactory on the International map of 1936. Silurian however may be regarded as a term used in a wide sense. The separation of the continental post-Tassilian beds from the rest of the series is unquestionably valuable in the field and carries conviction of the map, perhaps aided by a hint of their being in part Westphalian, in part younger.

The treatment of the Mesozoic and Tertiary beds is also of much interest. Three groups are identified: the "Continental intercalaire"; the Upper Cretaceous and Eocene transgressive beds; and the Neogene continental phase, which has continued to the present time. The Continental intercalaire was formed from Permian to Lower Cretaceous times, and is pre-Cenomanian. The term has been found very convenient in the field and it also avoids the difficulties involved by the use of "Nubian Sandstone": it expresses in fact the prolonged deposition, erosion, and redeposition of the products of subaerial denudation over much of the interior. There is evidence that the beds were at one time more extensive, and that they have been stripped off the highlands. Their mapped distribution raises the question: what was happening between the Niger and the Guinea coast and in the western Sahara when they were being formed in the interior? The reviewer is not aware of any entirely satisfactory answer.

A shallow sea invaded the interior, joined to the ocean in the south by the present course of the Bénoué, not by the valley of the lower Niger; the Cenomanian–Turonian beds contain marine fossils. After a Turonian–Senonian interval the sea returned and fossiliferous beds have been proved through the uppermost Cretaceous, Cretaceous–Eocene passage beds, to the Eocene, the

beds being concordant. The sea retreated during the Eocene. The marine beds are not mapped in the western Sahara or in the territories to the south of it to the Gulf of Guinea, but it is evident that the sea spread round the western flanks of the Adrar des Iforas and north-eastward to the southern flanks of Tibesti (Niger colony). There are patches of Tertiary beds along the Gulf of Guinea coast.

An Eocene gulf occupied most of Senegal, and the strata there are followed by non-marine Neogene deposits. Continental Neogene beds also occur along the Niger from upstream of Timbuctu into Nigeria, and stretch far to the north and east of the river, concealing the marine Eocene beds in many places. In the western Sahara and around the interior massifs "terrain des Hammadas," supposedly Upper Cretaceous or Tertiary, lie discordantly on the ancient rocks, all the Palaeozoic systems and probably the Continental intercalaire. One might see in them a continuity of the conditions of the last-named, and they were probably forming while the Cretaceous and Eocene seas lay to their south. The tale of the great desert is followed in the *regs* (partly formed from the *hammadas*) and sand dunes, that mark the present climate.

The great Quaternary basins and the terrestial, freshwater, and lacustrine deposits, like those of the Niger and Chad, fall readily into place: in fact the sequence of the whole, as M. Legoux remarks, leaves no room for the Quaternary interior sea, once so keenly debated.

The arrangement of the mapping for the whole of the Mesozoic, Tertiary, and Quaternary beds is excellent, and with the accompanying text tells a story which is fascinating and crystal clear. It is to be especially recommended because it demonstrates how essential is a knowledge of the past to a proper understanding of the deserts of to-day.

The eruptive rocks of various ages are shown on the map by two colours used in conjunction with eight petrological symbols.

The second part of M. Legoux's memoir deals with the mineral wealth of French West Africa, with reference also to non-French territories. It is an excellent review, limited to essential facts and of use equally to geologists and geographers: it is not primarily intended for mining enterprises, though useful to their technical staffs.

The following notes are intended only for the general reader and refer to French territories. In the memoir metalliferous bodies and ore deposits are classified regionally and attributed to their probable origins: they are not indicated on the map.

Gold, exploited so profitably in the Gold Coast, is found associated with, and derived from, the great Birrimian massifs and the highly metamorphosed Birrimian rocks: there are valuable alluvial and eluvial workings especially in French Guinea. The gold-bearing Tarkwaien rocks (banket) of the Gold Coast are not known in French territory.

Diamonds occur widely, but at present are industrially important in the Gold Coast, Sierra Leone, and in French Guinea: they occur in thin alluvial deposits and their origin is still rather ill defined, but probably lies in ultrabasic and some metamorphic rocks.

Titaniferous and zircon-bearing heavy sands are known in the beaches of the Senegal and Ivory coasts; alluvial and eluvial ilmenite also occurs in several localities, for example, Freetown and in Dahomey, where rutile also is found.

Phosphates occur in the Lower Eocene strata of Senegal and in 1935 deposits of considerable note were found at the junction of Cretaceous and Eocene beds north of the Niger 125 kilometres from Gao, in the dry valley of the Tilemsi; they are of good quality, ranking with the lower grades of Morocco.

Haematite iron ore has been found in highly metamorphosed Birrimian rocks in northern Mauritania, near Fort Gouraud, and recalls the important bodies already known and exploited in Sierra Leone; it probably occurs also in French Guinea. The ore also is found widely in the Ordovician sandstones both of the western French Sudan and of the Tassilis. Native exploitation of iron from laterite is, of course, widespread and well known: M. Legoux calls attention to the extensive occurrence of iron ore in the lateritized basic rocks of the Kaloun peninsula, near Conakry.

Bauxite is now to be regarded as a common occurrence, much of it being high-grade ore both in French and British territory. M. Legoux states that it is mainly associated with the Horizontal Sandstones, but that it also occurs on alluvial deposits and, in the Iles de Los, near Conakry, on syenites.

There are indications of manganese in the Ivory Coast and around Ansongo (Niger), but they do not seem to be comparable with the important exploitation in the Gold Coast: there are also scattered indications of copper and chromite in French territory.

Limestones suitable for cement making are rare in French West Africa. Bitumen seepages occur at Eboïnda, on the Ivory Coast.

Rock salt is worked by natives at Trarza and Idjil in Mauritania, and near Taoudeni (French Sudan); salt is also obtained from saline earths in several places in the Niger colony, for example, Bilma.

It is already well established that substantial mineral resources lie in French West Africa: many localities are unfortunately remote and their minerals at present not worth exploiting, and not all the ores are of high grade. But these are early days, and the impressive output of adjoining British lands, founded so largely on the work of their Geological Surveys, though tantalizing, may serve to encourage and inspire the French Service in its limitless and so largely inhospitable territories.

K. S. SANDFORD.

REVIEWS

EUROPE

THE ITALO-YUGOSLAV BOUNDARY: a study in political geography. By A. E. Moodie. *London: George Philip*, 1945. 8½×5½ *inches;* viii+242 *pages; maps.* 8*s* 6*d*

Dr. Moodie has produced a careful historical and geographical study of the Julian region, the borderland between the Italian, South German, and South Slav settlement areas. Part I deals mainly with the geographical features of this problematical no-man's land. Part II with its history from the earliest times until the outbreak of the first World War, and Part III with the difficulties in frontier drawing arising out of that upheaval.

The author has unquestionably produced an authoritative work on this region. The book reads as though he really knew his area, and had studied minutely and skilfully a good deal of tendentious documentary material. It is solid in its information and detached in its outlook, conveying throughout and correctly the idea of a troubled frontier zone, with its peoples distracted between the dangers of incessant warfare and the possibilities of transit trade.

Certain points emphasized in Dr. Moodie's study are of particular geographical interest. One is the problem of frontier demarcation in Karst country of subterranean hydrography: in such a region the well-known dependence on the watershed frontier line is misplaced. A second again concerns frontier drawing. In a land of traditional political insecurity peasant transhumance tends to persist. The attempt to adjust these pastoral migrations to the political requirements of a fixed demarcation line is most likely to lead to frontier incidents.

A third is the very able analysis of the growth of the regional ports, Trieste and Fiume. Dr. Moodie shows clearly the contrast between the meagre character of local trade and the substantial possibilities of long-distance transit trade, provided that the merchants of Trieste and Fiume can tap freely the hinterland of the Middle Danube Basin. So far the northern and eastern producing and manufacturing areas have meant more to the transit trade of the Julian ports than the lowlands of northern Italy. It is difficult to escape his conclusion that whatever the language distribution of the north-east Julian region immediately behind them, Trieste and Fiume are the outlets of a great part of Central Europe, and that any attempt to narrow their significance can only damage the merchant groups concerned.

The book is illustrated with some twenty black and white outline maps. Some of these are most interesting, for example, Fig. 4 (The Postumia Saddle) and Fig. 12 (The development of the railway net in the Julian region). The first three diagrams are not really adequate accompaniments to the very detailed regional description, especially as the general atlas will not solve the reader's problems.

Dr. Moodie's work will be valued highly by those who already have an acquaintance with frontier problems either as historians or geographers. It is on the heavy side for the general reader, and in his attempt to handle a mass of detail the author is rarely successful in conveying the idea of a landscape, or indeed of several landscapes. In this difficulty photographs would have helped considerably and it is to be hoped that a new edition may see this amendment. In the meantime a region and problems of intense and immediate interest have been well written up for the student. H. G. S.

ASIA

SOILS AND AGRICULTURE OF SZECHWAN. By H. L. RICHARDSON. (National Agri. Research Bureau. Sp. Publn. No. 27.) *Chungking: Ministry of Agriculture and Forestry*, 1942. 10×7½ *inches;* 164 *pages.* $10.00 *Mex.*

It is a remarkable tribute to the seriousness with which modern China regards basic scientific research that this publication should be issued by the National Agricultural Research Bureau at Chungking, that beleagured war-time capital of China, in 1942. It is published in English, with a two-page summary in Chinese, but in Chinese style, being printed on one side of folded leaves of very thin paper.

Dr. Richardson carried out extensive journeys in the province from February to December 1938 and the report is based mainly on his own observations for the literature is very scanty, only nineteen items are listed in the bibliography. He devotes considerable attention to climate and naturally to his own particular interest in soils. The reconnaissance soil map shows four world groups represented: brown earths, yellow earths, the much-disputed purple-brown soils, and alluvial soils, as well as mountain, meadow, and miscellaneous types. The zonal soil type of the heart of the Red Basin is regarded as yellow earth, but the predominant purple-red Szechwan series of rocks of intense colour and high base content results in the purple-brown soils being predominant in the basin.

The maps include one of rainfall, showing the heart of the province mainly a little below 1000 millimetres or 40 inches, one of land-use regions, and two of the distribution of cotton and sugar cane. As in so many parts of the world, soil erosion, mainly sheet erosion rather than the spectacular gulley erosion of north China, is a serious matter—indeed the basic problem is how to continue cultivation and at the same time to check erosion. The practice of the deliberate winter flooding of ricelands, described as a form of fallowing, illustrates how basically different are some of the agricultural problems from those in western countries and how important therefore is the work of the various new agricultural stations which have been set up and which are described. L. D. S.

THE OLD BURMA ROAD; a journey on foot and muleback. By NEVILLE BRADLEY, with a foreword by LADY ERSKINE CRUM. *London: William Heinemann*, 1945. 8½×5½ *inches;* viii+138 *pages.* 9*s* 6*d*

When he decided to make this journey to Rangoon in the spring of 1930, Dr. Neville Bradley was a medical missionary in Kunming. He evidently kept a full diary, as well as notes and photographs, and later told the story of his journey to Lady Erskine Crum, who set it down. The result was well worth publishing, as a record of travel through country where the conditions of travel have now been greatly changed by the construction of the famous Burma (motor) Road, and also as a record of what life in Yunnan, not to mention other parts of west China, was really like before it felt the impact of Western civilization and of the war against Japan. Even now the life of the people in western Yunnan (outside the temporarily occupied areas) has not been changed very much by the new Burma Road, which has been more concerned with through than with local traffic. But there is no question that profound changes will come, so that a record such as this will have considerable historical value.

The book also has present value as a pleasant and readable account of a strenuous journey. Dr. Bradley, with his companion, Mr. R. Lankester, had their full share of the travel troubles that one has to expect on a journey of this sort, including illness, dirty inns, and bandits to be dodged—troubles that are

more romantic to read about than to experience. He gives one tip that is worth passing on to others who may have to travel away from the motor roads in Yunnan: a horse-inn in Yunnan is to be preferred to the usual travellers' inn.

From the point of view of a geographical record, the book suggests that Dr. Bradley was more interested in people than in things. His descriptions of human conditions are enlightening, and his account of the distressing amount of disease and ill-health found among a people who have never suffered from the disadvantages attributed by some to Western civilization, might be taken to heart by those writers. Public health authorities' surveys show that the Chinese mortality and morbidity rates are the highest in the world, for any large nation; and yet one may still read such statements as: "For the last example of a people of outstanding health and stamina we must go back to the continent of Asia, to the people of rural China."

Dr. Bradley draws attractive pen-pictures of some of the landscapes he saw as he travelled, including a memorable description of sunrise behind the Tali range, as seen from a viewpoint 70 miles away to the west. His account of the beauties of the Tali district—lake, cultivated plain, old city, and mountain range—will be appreciated by any who have been there, and, it is to be hoped, may draw other travellers there in the future. In more technical matters little of scientific value is recorded: but, after all, it was not Dr. Bradley's object to collect scientific facts. Such matters may be found, for example, in H. R. Davies' 'Yunnan.'

A word of caution is necessary in the matter of the spelling, or romanization, of Chinese names in the book. Dr. Bradley seems to have used a system of his own, based on the Cantonese pronunciation, and readers who are not familiar with the vagaries of Chinese romanization may have difficulty in locating some of the places mentioned. It is greatly to be wished that authors would conform to the standard system of romanization of Chinese place-names given in the Chinese Post-office Guide; and in personal names or other Chinese words, the Wade system is now standard outside Kwangtung.

The book is illustrated by a limited number of photographs, some of which, such as the chain bridge over the Mekong, are of considerable interest. There is no map or index. H. L. R.

FLIGHTS OVER ANCIENT CITIES OF IRAN. By ERICH F. SCHMIDT. (Spec. publn. Oriental Inst. Univ. of Chicago.) *Chicago: Univ. Press*, 1940. 16×12 *inches;* xxii+104 *pages; with* 119 *plates, maps, and end-paper maps.* £6

Some of the results of two seasons' reconnaissance undertaken to observe archaeological sites mainly in south, central, and north-west Iran are published in this volume. The real value of the work lies in the series of one hundred and nineteen magnificent plates which represent a pioneer attempt to record the archaeology of Iran in air photographs comparable with Crawford and Keiller's 'Wessex from the air.' The text is largely a diary of the flights, with brief historical notes and references to ground survey and excavations.

The author, Dr. Schmidt, took over in 1934 from Professor Herzfeld the field-directorship of the excavations at Persepolis sponsored by the Oriental Institute of Chicago. The great results to be expected from archaeological air reconnaissance in the Middle East were first indicated by descriptions of observers in the 1914–18 war (see *e.g. Geogr. J.* 53 (1919) 330–5; 55 (1920) 109–27), and to excavators working at such a site as Persepolis the opportunity must have seemed great. Dr. Schmidt was fortunate in being able to organize two series of flights between 1935 and 1937. The expedition used a Waco cabin

biplane, chosen for its suitability for air photography, its low landing speed, and short take-off, evident advantages in the type of country illustrated in this book. Inspection of the legends below the plates shows that the photographs were taken in about seven weeks' flying, between mid-September 1935 and early June 1936, and in three brief excursions, each of about ten days' duration, in May, July, and November 1937. In this period five areas were reconnoitred, the environs of Persepolis and Rayy, the Gurgan Plain, western Azerbaijan, and Luristan, with the result that many hitherto unrecorded settlements and burial sites were identified and plotted on maps. In wild and mountainous country such as this, reconnaissance for archaeology or for any other purpose can only be undertaken quickly from the air, and the illustrations show what can be achieved by carefully planned air survey, in a very short time.

The plates, which include both vertical and oblique views, illustrate well their various subjects. The most valuable photographs are the detailed studies of individual sites, mainly mounds or standing ruins, which for their effective display require careful attention to shadows. They have been obtained from heights between 1000 and 4500 feet above ground-level with the sun at a low altitude. A most remarkable view of the Islamic city of Istakhr, near Persepolis (Plate 10), is in a class by itself. The remains had been recorded effectively as a shadow site the previous autumn (Plate 8), when the principal streets were revealed. But in the spring, under grass, a complete town-plan of buried streets and houses was revealed by differential growth of vegetation. Thus, the archaeological fact long familiar in England that variations in surface vegetation reflect conditions in the soil beneath is equally applicable under the very different conditions of climate and vegetation at Persepolis.

It is greatly to be regretted that further photographs of such vegetational markings are not published by Dr. Schmidt, they convey far more information than views of *tepes* and village mounds, however striking, while the extensive fields and areas of cultivation shown on the plates suggest that other opportunities can hardly have been lacking. Care will be needed to choose the right conditions, for vegetation is not always helpful as Plate 23 shows.

The environs of Persepolis are illustrated on Plates 1–24; there are several striking views of the main terrace, the site of the palaces of Darius and Xerxes. Here, air reconnaissance kept in close touch with excavations on the ground, and perhaps the outstanding achievement was the production of air photographs, which with carefully arranged ground control could be used as a basis for contoured archaeological maps. In a country where no large-scale maps are available an immense saving of time is effected by such means, since a few days work can yield a serviceable plan such as could only be obtained by many months of ground surveying.

Some of the plates are of the greatest value to the student of ancient town-planning. The larger sites seem to have decayed gradually, and to have been enveloped by desert sands and silts which cover them to varying depths. The buried structures may be revealed either by differential growth of vegetation as at Istakhr, already mentioned, or by faint shadows cast by disturbances of alluvial soil due to ancient constructions beneath, as at Dar-i-Shahr, an important town in the Sassanian and early Islamic periods. Besides these two sites there are illustrations of the Islamic towns of Mu'min Tepe and Rayy, of the Sassanian city of Gur, of Takht-i-Sulaiman, occupied from Parthian to Mogul times, and of several abandoned medieval towns of the Gurgan Plain. The last of these are revealed with an astonishing amount of detail (Plates 66–67), which recalls the plans of Eski Baghdad prepared from air photographs and published as long ago as 1919–20 (*Geogr. J.* vols. 53 and 55). A comparative set of photo-

graphs to a common scale, of the ancient cities of Mesopotamia and Iran is clearly an urgent need.

The single week that the expedition was able to devote to the Gurgan Plain yielded results which demonstrate the wealth and variety of archaeological sites in that area (Plates 57–72). The fertile land between the Gurgan river and the north slope of the Elburz mountains must always have been a coveted country to the tribes of the Turkoman steppes to the north, while it offers also an easy approach to central Iran by way of the south shore of the Caspian Sea. This invasion route is blocked by a defensive barrier which extends from the Caspian eastwards for at least 170 kilometres and consists, to judge from photographs, of a great earth wall with thirty-one square forts abutting on its southern face. The system, which superficially resembles Hadrian's Wall in the north of England, was presumably built between the conquests of the Macedonians and the Arabs.

But the new discoveries are not confined to plans of towns and forts. The archaeological maps prepared by Dr. Schmidt abound with the sites of ancient mounds, settlements, and cemeteries identified for the first time. The volume under review shows what results can be obtained by a single light aircraft in a few weeks' flying. It gives a clear indication of the immense opportunities for historical and archaeological research open to large-scale air reconnaissance.

J. K. St.J.

AFRICA

LONG RANGE DESERT GROUP: the story of its work in Libya, 1940–3. By W. B. Kennedy Shaw. *London: Collins*, 1945. 8 × 5½ *inches;* 256 *pages; illustrations and map.* 12*s* 6*d*

To those who were unable to follow closely the African campaign of 1940–2 the name Long Range Desert Group may well suggest a loosely-knit ever-changing formation of units of various arms temporarily linked in one command. In fact it was a single specialized fighting unit, which retained its unique character, composition, and fortunately many of the same personnel throughout the whole period of the desert war. The conclusion of the campaign enabled Major W. B. Kennedy Shaw to chronicle the work of the L.R.D.G. in Africa from just the right interval of time. Written in the later months of 1943, the conditions and incidents are vividly portrayed, yet the book shows no signs of haste or of the effects of war-time propaganda.

The author succeeds in setting out not only how the various tasks were schemed and carried out, but also why they were decided on and their place in the campaign as a whole. The ideal of the L.R.D.G. was to be able to travel to any point in the whole vast Eastern Sahara nominally held by the enemy, and there to reconnoitre, harass, or fight as required. As a record of adventure, well told, the book takes a high place, but it includes also a quantity of sound geographical and historical information that entitles it to a place among the few books on the Libyan Desert worth reading and keeping.

It is well equipped with good maps, specially compiled and giving information not yet published elsewhere. There are plenty of well-chosen and interesting photographs and reproductions of drawings. Some of the former could have had their interest increased by rather fuller titles, and by the inclusion (Plates 13, 27, and 30) of some familiar object to give the scale, or a statement of the approximate size of the features shown. The five appendices will be valued by those associated with the unit, and there is a good index (the reference therein to Sir Reginald Wingate should be to the late Major-General Orde Wingate).

Major Kennedy Shaw has set a high standard for whoever chronicles the subsequent work of the L.R.D.G., for they shook off the sand and carried on doing similar good work under the same name, afloat and ashore, right up to the end of the war in Europe. P. A. C.

CENTRAL AND SOUTH AMERICA

INTRODUCCION A LA GEOGRAFIA DE CUBA. I. Geografia fisica. By SALVADOR MASSIP and SARAH E. Y. DE MASSIP. *La Habana*, 1942. 9½×6 *inches;* xiv+250 *pages; illustrations, sketch-maps, and diagrams*

This geography of Cuba is the result of twenty years of investigation; there has been a long delay in publication owing to the accidental destruction of the first set of blocks. The first volume deals with the physical geography of Cuba, and a description of its structure is followed by an account of the physical evolution. The main part of the book is devoted to a regional description of the land-forms, the island being divided for this purpose into four main regions. Separate chapters are given to the coasts, the climate, the flora, and the fauna. There is a useful bibliography, but, unfortunately, no index. It is presumed that a further volume on the human geography of Cuba will eventually be issued, and possibly the later volume will include a complete index.

The regional descriptions are illustrated by a large number of admirable block diagrams and drawings made by Dr. Erwin Raisz and by many photographs. Before the publication of this book, recent geographical information concerning Cuba could only be found scattered in periodicals, and it is most useful to have a detailed physical account of this important island. In view of the growing interest in the islands of the Caribbean the authors are to be congratulated on making an important contribution to the geographical knowledge of that region. E. W. G.

AUSTRALASIA AND PACIFIC

STONE MEN OF MALEKULA: the small island of Vao. By JOHN LAYARD. *London: Chatto and Windus*, 1942. 10½×7 *inches;* xxiv+816 *pages; illustrations, diagrams, and sketch-maps.* 50*s*

This immense volume, conceived on the ample scale of pre-war anthropological publications, is intended as merely the first of a series which will give the results of the author's field research on Vao and Atchin, two of the group of Small Islands lying off the north-east coast of Malekula in the New Hebrides. Though the original field-work was carried out thirty years ago, despite the inevitable changes in the local conditions since then, the account has great value, both as a historical record and as a contribution to the anthropology of a little-known area. It also includes some material from the work of the late Père Jean Godefroy, a Marist priest whose publications on the culture of the people of Vao are not readily accessible or indeed known to the anthropological world in general.

The Small Islands have not hitherto been known as such to geographers. The term is a pidgin-English one used by the local natives to distinguish the group from the Big Island of the Malekula mainland. They are all of coral formation, and of unequal elevation, the outer or seaward sides being slightly cliffed and the inner sides, facing the channel between them and Malekula, having a good sandy beach in each case. The islets are too small and their soil is too shallow to support the population by agriculture, and the main gardens of the natives are on Malekula, to which they have access by means of small sailing or paddling canoes. An additional reason for thus separating cultivation from residence is

that large numbers of pigs, which are of great importance in the ritual institutions of the people, are reared on the islets and destroy much of the vegetation. Communication and intermarriage among the people of the various islets is frequent, and they share the same type of social structure and rituals, though with significant local variations, the analysis of which has added greatly to the interest of this book. Despite their contiguity and cultural similarities however the people speak different dialects—with the exception of those of Wala and Rano, which are approximately the same.

The book opens with a brief geographical and sociological introduction, and then proceeds with a detailed analysis of the social organization of the people of Vao, who, although numbering little more than four hundred, have an elaborate "class" system or "section" system of a type already described by the late Bernard Deacon from Ambrim, and well known as one of the most characteristic features of the culture of the Australian aborigines. In order to explain this system more clearly, Dr. Layard has given an account of the basic structure of such systems in Australia and Melanesia, illustrating this by an ingenious set of diagrams presenting some novel projections of the material. The basic principle of construction of these diagrams is a simple one, and the reader trained in the intricacies of Australian kinship systems will have no difficulty in grasping their meaning, but the author's claim that all the essential facts are presented "at a glance" will probably be hotly contested, even by most anthropologists. The geographer will probably skip this part of the book, which will be a pity, because as far as it goes the exposition of this important and difficult subject is very lucid. For Vao itself the analysis is suggestive but not definitive. The author did not spend a long time there, much of his kinship material is based on records collected by aid of the genealogical method from one informant, and he himself states with scientific candour that at the time he was not able to understand their full significance. Moreover the logic of his argument at one basic point is not too strong. On p. 126 we are told that on the author's re-examination of the kinship material he collected, in the light of later knowledge, it began to appear that the kinship terminology of Vao had not kept abreast of actuality, and "probably represents an archaic system based on overt matrilineal descent such as clearly existed till comparatively recent times in the Small Islands," though now the organization is patrilocal. On the following page this supposition is treated as a fact, giving the basis for a study of the culture-change which has occurred. "This being the case, we have the interesting phenomenon of a kinship terminology based on overt matrilineal descent surviving in an area that is now overtly patrilocal, thus affording a rare opportunity for the study of change arising from this circumstance." That there is really a piling-up of hypotheses here is not made clear, and the reader cannot help asking the question—might further research on Vao perhaps not have demonstrated that the kinship terminology had kept abreast of actuality, and did reflect accurately existing social usages? However Dr. Layard has put forward an extremely ingenious historical reconstruction; his dissection of the material into a twelve-section system, a type not hitherto postulated, is also very interesting.

A most important part of the book is that dealing with the ritual life of the people, especially with the rites of the *maki*. This institution involves propitiatory sacrifices of tusked boars to the ancestral ghosts, and the erection of stone monuments and tall wooden gongs to the memory of the ghosts, as well as the outlay of immense quantities of yams and other foodstuffs in feasting to kinsfolk. By such means the principal participants ensure for themselves a life after death, with status appropriate to their expenditure, and also attain rank

and prestige in this world. The rites are progressive for each individual, the result being the organization of a graded society, in which advance is signalized by the assumption of new names and titles as each new step is reached. The graded society is a basic feature of the culture in this part of Melanesia, and is linked with much of the social, economic, and political life of the people. Dr. Layard's elaborate and well-illustrated account of this whole institution is a valuable contribution; among many noteworthy sections is one on the gong-rhythms, songs, and dances of the *maki*, embodying analysis of a type rarely found in anthropological accounts.

One error in historical nomenclature may be noted on p. 5, Quiros did not give the name "Terra Australis del Espiritu Santo" to the island he discovered and which is now known as Espiritu Santo. He found it during his search for the reputed southern continent of Terra Australis Incognita, and named it "Austrialia del Espiritu Santo," in compliment to the Austrian descent of the King of Spain. R. F.

PHYSICAL AND BIOLOGICAL GEOGRAPHY

GEOLOGY FOR EVERYMAN. By Sir ALBERT SEWARD. *Cambridge: Univ. Press*, 1943. 8×5 *inches;* xii+312 *pages; illustrations and diagrams.* 10*s* 6*d*

Several things soon impress the reader of this book: first, the author's love of his subject, his power of making things clear yet imbuing the reader with a sense of exploration and discovery; secondly, the essential part that botany and palaeobotany can play in a science that usually gives them but perfunctory attention; thirdly, the author's method of describing the strata in reverse order to their age, *i.e.* from the last Ice Age to the Pre-Cambrian. The arrangement is unusual, but it has the merit of taking the reader from the known to the unknown; as Seward handles his material the method succeeds, and becomes logical.

Few could have set themselves the task of writing a book like this without introducing and explaining a host of scientific terms or affronting their readers by over-simplification. No one should find the book difficult or dull. There are innumerable examples from British geology that interested readers, wherever they live, can readily sample for themselves; but Seward draws his evidence, especially his palaeobotanical evidence, from every quarter: Greenland, the Himalaya, Australia, the Antarctic, all are weaved into his narrative. "Everyman" can learn much from this book and from the field work it encourages, and can enjoy the experience; but few will get greater pleasure from it than the student of geology who wishes to learn in simple terms what palaeobotany can contribute to his science. The book bears something of the charm, far-sighted reflective enthusiasm, and kindly interest in younger men that were so essential a part of its author. K. S. S.

THE MONTHLY RECORD

THE DEVELOPMENT OF CENTRAL BRAZIL

Some months ago we received details of an organization which proposes to undertake the economic development of an extensive and largely unexplored area of Central Brazil, stretching between the State of Goyaz and the River Huazon. This organization, the Fundação Brasil Central, owes its inception to the initiative of Senhor João Alberto Lins de Barrôs, and is controlled by a Board nominated by the President of the Republic.

An expedition organized by the Fundação in 1943 left a base at Rio Bonito, Goyaz, for Barra das Garças at the confluence of the Rio das Garças and the Rio Araguaya; thence it continued northwards for 120 kilometres to the Rio das Mortes. The intention then was to proceed in a north-north-westerly direction, to make contact eventually with another party which was moving southwards from the Amazon, and had by the end of last year reached a point some 200 kilometres south of Collectoria on the Rio Tapajoz.

The expedition is building a road as it goes along and as each fresh base camp is established at intervals of about 120 kilometres an airfield is constructed. When this chain of airfields has been completed it is hoped that the express trunk air service, which now flies via Trinidad–Para–Barreiras, may be diverted to this route through Manãos, the estimated saving in time being six hours. These bases are also intended to serve as centres for the colonization which is the main object of the expedition. Apart from a small floating population, the region is peopled by Indian tribes which up to the present have been protected from outside influences. Hopes of attracting any considerable number of colonists from other parts of Brazil and from Europe depend primarily on its economic possibilities which have largely to be determined. Mineral resources have not been investigated in detail. These with the extraction of babassu oil might form a basis for development, and it is considered that, if some means of overcoming the handicap of the winter drought can be found, cattle could be raised on the savannahs and a dried-meat industry established. The problem of creating an agriculturally self-supporting population around these centres presents many difficulties, and will require careful investigation. The sense of isolation on the part of the settlers has proved a great difficulty in the past, but this may be overcome by the development of air communications. The relations between colonists and Indians will also require careful attention. Further information on the progress of this enterprise will be awaited with interest.

THE TIDE IN LONDON RIVER

When Kipling speaks of "Tide-end-town which is Teddington," his etymology is false, but he makes it easy to remember how far up the Thames the tides flow. About 16 miles below Teddington (or Totyngton) lies the little gravel islet of Thorney, on which the first Westminster Palace was built for King Canute. It was probably here, if the legend be founded on fact, that he set up his throne at the water's edge and forbad the tide to rise higher.

While Canute could not prevent the rise of the tide, it would be by no means impossible for us to-day to prevent its fall from Trinity High Water Mark, about 12½ feet above Ordnance Datum. For a number of years the Thames Barrage Association has been urging that the level of the river through London should be maintained by a barrage, as has been done, for instance, on the Charles river at Boston, Mass. In the latest publication by its secretary, J. H. O. Bunge ('Tideless Thames in future London,' 1944), the site selected for the barrage is

at Woolwich. Such a scheme has many obvious advantages, which are clearly set forth, while some objections that have been raised are answered. Unfortunately the question has been acutely controversial. It would therefore be advantageous if the scheme were investigated by an independent body.

Many plans for the post-war improvement of London have been made public; drawings of the proposed improvements that include the river invariably show it at high water. The pros and cons of making riverside wharfs accessible and the river itself easily navigable at all times, the means of disposing of storm water, and many other points involved must be left to experts; but every Londoner and every visitor to London would be glad to get rid of the mudbanks now exposed at low water.

One point that has not yet been made in any publication may be briefly put forward here. Around Deptford the river traverses a geological dome, which brings the chalk up to the surface. Under natural conditions springs were given out from this Chalk, the overflow of the so-called underground reservoir of London. But so heavily has this water been pumped during recent years from boreholes that, as Dr. S. Buchan has described in the 'Water-supply of the County of London from underground sources' (*Mem. Geol. Surv.*, 1938), brackish water is now drawn in through the Chalk in the river-bed. Many water-bores in Bermondsey and Southwark have had to be abandoned owing to the increase in salt-content, and the trouble is steadily spreading westwards and northwards into the City. If a barrage to exclude the tide were built farther down the estuary, a gradual recovery might on the contrary be expected.

C. E. N. B.

HIMALAYAN TECTONICS

At approximately the same time as Hans Schardt made his revolutionary discovery that the Prealps consisted of a complex of Mesozoic and Kainozoic rocks thrust over autochthonous Kainozoic formations, equally momentous discoveries were being made in the Himalaya by C. L. Griesbach, C. Diener, and C. S. Middlemiss in 1892. In the Kiogar-Chirchun district, between the upper Sutlej and the Ganges, these geologists found that two facies of Mesozoic and Palaeozoic sediments, now known as the Himalayan and Tibetan, are brought into juxtaposition. This area was later described by A. von Krafft, whose memoir (*Mem. Geol. Surv. India* 32 (1902) 127) is still the principal source of information on its geology. Recently important additions to our knowledge of these formations have been made by Arnold Heim and August Gansser (*Mém. Soc. Helvétique Sci. Nat.* 73 (1939) 74, 184). Prior to this E. B. Bailey advanced a spectacular interpretation of the mountain-building movements and prophesied that certain rock-types had been misidentified by von Krafft (*Bull. Geol. Soc. Amer.* 47 (1936) 1722). These forecasts were substantiated by the recent work of Heim and Gansser, with the result that Bailey has advanced his previous far-reaching deductions in a lecture to the Royal Institute in 1944 (*Nature*, 154 (1944) 752).

In the Kiogar-Chirchun district the Himalayan facies of Mesozoic age comprise some 2000 feet of Lower Cretaceous sandstones containing fragments of volcanic rocks, succeeded by about 2000 feet of Upper Cretaceous shales which in turn are followed by approximately 1000 feet of radiolarian cherts. The Tibetan Mesozoic facies, consisting chiefly of limestone, are distributed as extensive masses or isolated blocks capping the peaks of the Kiogars. Between the Tibetan and the Himalayan is a thick group of igneous rocks comprising andesitic lavas and intrusions of serpentinous rocks. While the igneous rocks are intrusive into the overlying Tibetan sediments, they also undoubtedly have volcanic relations to the underlying autochthonous Himalayan rocks.

Since the discovery of Griesbach and his colleagues in 1892 it has been known that the severely shattered and folded Tibetan sediments have travelled enormous distances; but the presence of the intervening igneous complex has caused much speculation. Von Krafft suggested that these igneous rocks operating either through the force of explosions or through the floating agency of lava streams were responsible for the transportation of the overlying Tibetan rocks. Other things apart the enormous size of the transported masses hardly fit into this interpretation. Several other theories have been advanced to explain the presence of this intervening igneous complex. Suess (*C.R. Acad. Sci. Paris*, 139 (1904) 714) recognized the Tibetan rocks as far-travelled thrust masses, but suggested that the intervening igneous rocks were intruded into their present position during the forward progress of the thrust mass. This hypothesis while accounting for the intrusive relationship of the andesitic lavas to the overlying Tibetan does not fully explain their apparent extrusive contacts with the Himalayan sediments.

E. B. Bailey was attracted to this tectonic problem through Suess, and after consideration of all the available evidence he advanced the following deductions and conclusions in 1936. Examining the descriptions of the rock-types by von Krafft and his colleague Thomas Holland he found that most of the lavas were relatively basic and distinctly amydaloidal and described as spheroidal or sack-like in structure—a feature they attributed to spheroidal weathering. Bailey points out that from their descriptions this rock is undoubtedly a typical submarine pillow-lava. Recalling Steinmann's world association of pillow-lavas with serpentinous rocks and radiolarian cherts Bailey next searched the records for a rock-type which would prove to be chert. This he suggested was the rock described by von Krafft as a "very thin-bedded tuff." Proceeding further with his researches into the literature Bailey came to the conclusion that volcanic activity started in the Tethys somewhere near the Kiogars early in Cretaceous times and provided the fragments of volcanic material found in the Himalayan Lower Cretaceous glauconitic sandstones. A quiescent period probably followed during which shales were deposited and during quiet intervals in the succeeding period of vulcanicity the radiolarian cherts were formed. Later the volcanoes became more active and poured out submarine lavas, some of which had characteristic pillow structure. While these volcanoes were still active the more remote Cretaceous deposits of Tibetan facies were thrust forward over this area with the result that large masses of these rocks were injected by lava. This clearly satisfies the known facts regarding the relationships of the lavas to the Himalayan and Tibetan rocks.

When Heim and Gansser proposed investigating this area Bailey urged them to examine von Krafft's localities. In 1939 the results of their work substantiated Bailey's prophecy by establishing the presence of radiolarian cherts in those areas described by von Krafft as composed of "thin-bedded tuff." However they suggest that large blocks of Tibetan sediments have slipped down from the coast-line of the Tethys to become embedded in the submarine lava-flows, and that the forward thrusting of the Tibetan area over the autochthonous Himalayan rocks followed later.

In his lecture to the Royal Institute Bailey disposes of this suggestion by pointing out that while their explanation satisfies the intrusive relations of the lavas to the Tibetan the scale of these suggested landslides is too vast to be accepted. In addition the presence of the volcanic debris found in the Himalayan sandstones is used as an argument by Bailey to prove that these volcanoes were situated much nearer the Himalayan area of sedimentation than is implied by Heim and Gansser.

It seems apparent, then, that we have in the Kiogars an unparalleled problem in mountain building awaiting further attention. Taking the evidence available it seems that Bailey's attractive interpretation must stand, and the Kiogars become, until further light is shed on the problem, the world's most remarkable geological monument to mountains which have travelled over volcanoes.

W. D. E.

ESKIMO POPULATION IN THE EASTERN CANADIAN ARCTIC

The *Canadian Geographical Journal* for September 1944 contains an interesting paper on the Eskimo population in the Canadian Eastern Arctic by J. Lewis Robinson. Mr. Robinson first considers in broad terms the present regional distribution of the Eskimo population as revealed in the 1941 census. A table giving the density of population, both per square mile of land and per mile of coastline, in the major districts, shows that certain regions are sparsely populated compared with others. The possibility of transferring some families from the more highly to the less highly populated regions, in order to prevent too great a strain on the local resources, is considered. With a total population of only 7700 in an area of 872,000 square miles and with over 40 square miles to each Eskimo in the most crowded part however it is difficult to believe that any region really contains more people than it is capable of supporting, especially as there is much evidence to show that a century or two ago there was a far larger Eskimo population. Boas, in "The Central Eskimo" (*Ann. Rep. Bur. Ethn.* 1884–85), shows how serious this decline has been in southern Baffin Island. The solution to the apparent present-day over-population lies, surely, in Mr. Robinson's alternative suggestion of increasing the productivity of the area. It must be possible by conservation, wise game laws, efficient administration, and a careful scientific study of arctic conditions to replace the loss caused by the universal adoption of fire-arms and the uncontrolled slaughter by commercial interests in former days.

To illustrate this regional survey there is a carefully compiled map showing the location of Eskimo camp sites in the Eastern Canadian Arctic according to the latest reports, with a supplementary map giving the total number of people in each group of camps. The detail is unfortunately too great for the small scale on which the map is reproduced, and it is very difficult to distinguish between the different types of symbols used, but it is certainly a valuable contribution to arctic data.

The paper concludes with several tables giving vital statistics for the Canadian Eskimo and showing in particular the high birth and death rates as compared with the rest of Canada. In the years immediately preceding the 1939 war, the Eskimo population seems to have been slowly increasing, but in the last three years, probably due to additional contacts with white people as a result of the war, there have been many serious epidemics, resulting in more deaths than births.

OBITUARY

ARTHUR ROBERT HINKS, C.B.E., F.R.S.

Secretary, 1915–45

Arthur Robert Hinks, who died at Royston on April 18, was born in Londo in 1873. From Whitgift Grammar School he went up to Trinity College Cambridge, and in 1895 was appointed assistant at the University Observatory under Sir Robert Ball, being promoted to chief assistant in 1903. His astronomical work was mainly on the measurement and reduction of celestial photographs and the determination of stellar parallax. He also determined the sola parallax from observations of Eros, for which he received the Gold Medal o the Royal Astronomical Society in 1912, and was elected an F.R.S. in 1913 From 1909 until 1913 he was Secretary of the Royal Astronomical Society, and Vice-President, 1913.

Hinks' association with our Society began in 1908, when he was appointe Lecturer in Surveying and Cartography at the Cambridge School of Geography. His first appearance before the Society was in 1909, when he rea to the Research Department a paper on the determination of position nea the Poles. Three years later, during the Presidency of Lord Curzon, he wa appointed Assistant Secretary to take over from Sir John Keltie the administrative work of the Society, and in 1915 he succeeded Keltie as Secretary and Edito of Publications.

In 1913 the Society had moved from 1 Savile Row to its present House i Kensington Gore, a landmark in its history. To the adaptation of the building for its new purpose and to the organization of its present facilities Hinks gav much care and thought, as also to the reorganization of its administration During his early years of office, war imposed inevitably a strain upon th Society's resources, and he showed much skill in piloting it through a difficul period, to be rewarded by the renewed access of strength from 1919 onwards For most of the war years, the available staff, with a fluctuating number o volunteers, was engaged under his direction in work for the Geographica Section of the General Staff. The principal result was the production of on hundred sheets of a provisional edition of the 1/Million Map of Europe; a star was also made with a 1/Two Million Map of Africa. He also undertook an in vestigation into the complex question of the projection upon which the map o France was constructed, in connection with a uniform grid for the Weste Front, and was engaged at the armistice in preparing an account of methods o sound-ranging, a task which took him on a brief visit to the front. For hi services he received in 1920 the C.B.E. and the Belgian Chevalier de l'Ordre d la Couronne.

In the years following 1918, he was engaged first in re-establishing th activities of the Society and then in developing them in new directions. Muc work fell to him in connection with the preparation of plans for the new build ing which was opened at the Centenary of the Society in 1930. He prided him self on the good acoustics of the new Hall, and it was due to his persisten that it became possible to project 16 millimetre films successfully in it. H introduced improvements in the typography of the *Geographical Journal*, an in the lettering and general design of the maps which accompanied it. He wa always ready to defend the style, which he evolved in cooperation with th younger draughtsmen, against more conservative views and had the satisfactio of seeing it widely adopted. He also initiated the 'Technical Series R.G.S.

Phot. Hugh Ruttledge

and contributed to it monographs on wireless time signals, geodetic tables, and the figure of the earth. His interest in cartography and map reproduction was displayed also in the Society's series of reproductions of early manuscript and engraved maps. His general views on cartography are set out concisely in his Presidential Address to Section E of the British Association (Southampton 1926), and perhaps the Map of Europe and the Middle East, produced for the British Council in 1942, represents most effectively the results of his long experience in this subject.

On the establishment of the Permanent Committee on Geographical Names in 1919, Hinks acted for some years as its Secretary and later served as one of the representatives of the R.G.S. until his death. His knowledge of its history and development helped the Committee to overcome many difficulties, and he gave firm and continuous support to its principles and decisions, particularly in the *Journal*. An example of his interest in these matters is seen in his attempt to reconcile "basic" Gwoyeu Romatzyh with the R.G.S. II system in the Romanization of Chinese place-names (*Geogr. J.* 102 (1943) 67–71).

From its inception in 1920 until 1939 Hinks served as one of the Honorary Secretaries of the Mount Everest Committee of the Alpine Club and the R.G.S. Apart from his assistance in the general organization of the Expeditions, he encouraged the scientific side as far as was possible in the circumstances, particularly survey. He acquired much knowledge of the topography of the area from his study and interpretation of the photographs, and this he turned to good account in the identification of the Everest Flight photographs, and the preparation of a map of the region from the obliques.

Hinks had proposed to retire in 1939, and looked forward to visiting the Mount Wilson observatory and to working on a map of the heavens. In view of the unsettled situation however he continued in office at the request of the Council, and hoped to see the war through at the Society. Much of his time was spent in answering technical questions put to him by the Service Departments. He kept in touch with developments in long-distance navigation, and in this connection he calculated a number of oblique Mercator projections, which, besides revealing unfamiliar relationships between the land areas of the world, simplified the drawing of great circles and the determination of their length. The idea of these oblique projections came to him while thinking over a possible mural decoration for a proposed Polar Exhibition. He gave much thought to the calculation, design, and reproduction of the Map of Europe and the Middle East, and to the subsequent Arabic edition. During the war he spent most of his time at the Society's House, combining fire-watching with his work for the *Journal*. He was on the roof at the time a high explosive bomb did considerable damage to the House in February 1944.

Appreciations of Hinks' work in survey and geodesy and of his assistance to intending travellers by those better qualified to write of them follow this summary of his activities. To complete it some indication should be given of his other interests; his contributions to the *Journal*, in which in recent years the bulk of his work appeared, give a good indication of their range.

As has been noted, his first paper to the Society dealt with the determination of position near the Poles, and in this he suggested a graphical means of treating observations on a modified Sumner method. Captain Scott raised at the time the practical difficulty that, in conditions of polar travel, calculation was necessarily much easier than any graphical construction: with the development of the aeroplane in exploration however this drawback was largely removed; thus in 1926 there is a "Second note," applying it to the conditions of a polar flight. This method was used by Admiral Byrd on his flights to the North Pole, and,

by means of it, Hinks was able to reinterpret the observations of Peary at the North Pole, and of Scott and Amundsen at the South Pole. His careful and thorough analysis of the evidence for priority of discovery in the South Shetlands and Graham Land was a further important contribution to Antarctic history. Another subject in which Hinks maintained his interest was the technique of boundary delimitation. In 1918 he had prepared extensive notes for the G.S.G.S., which were published later in the *Journal* (58 (1921) 417), and after the war of 1914–18 he contributed many notes on the new boundaries of Europe, and clarified the treatment of the subject considerably.

His method of preparing the eleventh edition of volume II of 'Hints to travellers' was very characteristic; the book was based upon his careful and penetrating cross-examination of many travellers, supplemented by apposite quotations from papers in the *Journal*, and rounded off by the results of often lengthy correspondence with manufacturers. As he confessed in the introduction, the subjects investigated were often those which appeared "interesting and amusing to himself"; to this scientific curiosity is due the classification of tents and cameras, the arithmetical examination of rations, the drastic corrections to the makers' ideas of the relation between altitude and the internal pressure of cookers, a table correlating aperture, exposure, and emulsion speed, and other useful but neglected subjects. It is also characteristic that numerical or graphical treatment was applied where possible, that dogmatism was avoided, and that practical experience was the final test. The dinner which those who had assisted in the work gave to him on the publication of the volume was a happy tribute to his achievement.

In 1938, on the eve of his projected retirement, the Council recognized his work for the Society and his scientific eminence by the award of the Victoria Medal. The American Geographical Society's Cullum Medal, inscribed "Like Ptolemy, learned in the mathematics of the celestial and terrestrial spheres," which he received in 1943, was a source of great satisfaction to him, and was an added incentive to press on with the third edition of his 'Map projections,' on which he was engaged till within a few weeks of his death. G. R. CRONE.

It was, I think, in 1903 that I first met Hinks. He had applied to the War Office for permission to study the survey methods which were taught at the School of Military Engineering at Chatham, where I was Instructor. He stayed with me for a month and was made an honorary member of the mess and was given every opportunity to see how the young officers were taught. We had then, in spite of some official opposition, definitely switched over to the Survey of India system, to the benefit, I am sure, of future work in the Empire, and he took much interest in the course of instruction. As an accomplished astronomer the calculations of field astronomy were, of course, child's play to him, though he had naturally something to learn about light field instruments and their use, and still more to study about non-astronomical topographical work. A few years before this I had become interested in the theory and use of map projections; he took to this study keenly, and his liking for it bore fruit eventually in his book on 'Map projections' which is such an excellent introduction to the subject.

Later we still corresponded on various technical matters. In 1909 there came the first International Map Committee which worked at the Foreign Office and was opened by Sir Charles Hardinge, then Under-Secretary of State. Keltie represented the R.G.S. at this Committee, a small body representative of nine countries, which came to unanimous conclusions. After the Geographical Congress, in Rome, in the spring of 1913, it was decided to call a larger con-

ference at Paris in the winter, to standardize the map completely. Hinks had now become Assistant Secretary of the R.G.S. and he took Keltie's place at the Paris Conference, and proved himself a very useful delegate, being one of the four representatives of Great Britain. The Conference opened on 10 December 1913 and held its last meeting on the 18th of that month. In after years Hinks tended to complain of some of the decisions of the Conference, but in the main they have held their ground. He liked the lettering, the characteristic signs and some other features, but did not like the application of the "layer" system. Perhaps the best vindication of the international plan is the great series of the whole of South and Central America published by the American Geographical Society. And that serves to illustrate one of his contentions, that to secure uniformity and to get the work done, it should be entrusted in huge blocks to definite organizations.

But it would have been difficult to persuade a gathering of the representatives of thirty-five countries to agree to such a scheme. During the war of 1914–18 Hinks found a very congenial task in organizing the compilation of a large block of sheets, on the international scale of 1/M, for the Geographical Section of the General Staff. This series followed in general the Paris resolutions of 1913. To use his words, "This irregular and unauthorized edition of the 1/M map proved invaluable during the war, and was officially adopted as the base map at the Conference of Peace." The labours of the two conferences of 1909 and 1913 were therefore fully justified, in an unexpected fashion, apart from the normal development of the scheme.

Hinks was a member of the National Committee for Geography, a committee formed under the auspices of the Royal Society to deal chiefly with international meetings. He was not enthusiastic about this organization of scientific unions, and, indeed, so far as geography is concerned, the old system, under which congresses were held at the invitation of the principal geographical societies, has something to recommend it. He attended many geographical congresses, the last one being that of Warsaw in 1934. Here he was elected the chairman of the committee which had to report upon the finances of the International Geographical Union. He took an abiding interest in geodesy and did valuable work in this field; his chief contribution being, perhaps, his introduction of graphic methods for use in the comparison of the results obtained by using different figures of the earth. His exposition of these methods will be found in the *Journal* for June 1927, where also will be found an account of the discussion on the subject which was held at the Society's House. The geodesists then present all expressed their appreciation and approval of Hinks' elegant methods. These will also be found explained in the latest edition of his well-known book, 'Maps and survey.' He took an important part in discussions on the subject of the figure of the earth at various geodetic congresses and conferences, including the important meeting at Madrid in October 1924.

He spent much time and trouble over the preparation of a new edition of vol. I of 'Hints to travellers.' The edition was badly needed, for improvements in instruments and methods had rendered the former edition of 1921 much out of date. Hinks gave an account of the alterations required for this last eleventh edition in the *Journal* for October 1935. In this account he minimized his own share in the work of revision, which was very considerable. It was fortunate that the new edition was in the hands of an experienced astronomer, for many of the changes concerned the astronomical sections of the book. I had some discussions with him on the matter and, except in one case, thought that he had admirably managed to select what was important to explorers in the field and had explained the fresh matter simply and clearly. But the revision was no light

task, and it was carried out in the midst of the continuous and exacting work devolving upon him as Secretary.

He spent the days of his last illness in working upon the third edition of his book on 'Map projections.' He was particularly investigating the relations between Clarke and Henry James and their respective projections, and was devoting much attention to the group of conical projections. I had many letters from him which dealt with these and other projection matters, and our correspondence continued to within eighteen days of his death.

C. F. Arden-Close.

I first met Arthur Hinks when I was home on leave in 1915. We had already corresponded about the results of some geodetic triangulation and photographic survey which I had carried out in the Chinese Pamirs in 1913, and plotted with the Vivian Thompson stereo-plotter. The Secretary of the Society was already fully conscious of the developments in stereo-photogrammetry, and anxious that the Society should keep abreast with them. Immediately the war was over Hinks was the first to discover the technical advances that had been made on the continent and their application to topographical survey. In those days air-survey was in its infancy, photographs being taken by hand cameras held by the pilot; continental developments from the British and Von Orel plotters were all concerned with ground stereo-photogrammetry. Hinks was always keenly interested in the exploration activities of the Society and naturally anxious to use the new method of survey in exploration. The result was that, when in 1925 I obtained permission to continue the Karakoram exploration left unfinished by De Filippi in 1914, it was natural to turn to Hinks for advice regarding the most up-to-date equipment. His action was characteristic. He made a special journey to Italy, Switzerland, and France, to discover at first hand and by actual discussion with the designers which instruments and what processes would best suit my requirements, and he wrote a long report on each in order that I could choose. Then, when I could not return to England, he persuaded the Society to purchase the Wild photo-theodolite and offered to act as agent for me in England, to buy all my photographic and other equipment and supplies, and to see them safely packed and despatched to India.

This action is characteristic of Arthur Hinks' devotion and help to many travellers during the period between the two wars. Whether it was an Everest expedition or a less grandiose piece of original work, nothing was ever too much trouble for him. The result was that he kept in close touch with explorers both during their travels and afterwards, and built up a store of knowledge and sound advice which he was ever ready to pass on. At the end of my own Central Asian exploration he not only arranged for the photographic plotting in Switzerland, but also accompanied me as adviser when the work was in progress, studied the design and mathematical principles of the Wild Stereo-Autograph, and discussed with the designer its application to air photography. Indeed, he became so convinced of the possibilities of survey by oblique air-photographs that he made himself master of its technique, and when the centenary additions were being made to the Society's House, he persuaded the Council to include a room for stereo-photogrammetry in the designs. It was also largely due to him that a part-time research assistant in photogrammetry was added to the Society's staff, and that the photographs taken on the flight to Mount Everest were made use of for a new map of the region. Unfortunately others in Great Britain were less far-seeing, so that on the outbreak of war in 1939 this country was much less advanced both in air apparatus and in air technique than most continental countries.

The interests and prestige of our Society were always uppermost in his mind. At many continental capitals he was regarded with affection as the true ambassador of his subjects, accurate in discussion and with a vast store of knowledge. With many of the best brains abroad he kept close contact long after the international meetings were over, and was welcomed when he visited their homes. The last of these international meetings which he attended was the Fifth International Congress of Photogrammetry in Rome at the time of the Munich crisis in 1938, when he was the sole representative from Great Britain. His report, published in the *Journal* for March 1939, contains an appeal for a broader appreciation in this country of scientific developments abroad.

KENNETH MASON.

SIR DOUGLAS NEWBOLD, K.B.E.

In February 1945, while riding in Khartoum, Douglas Newbold was thrown by his horse shying suddenly and fell on to his hip in which he had suffered from arthritis in recent years. At the time he did not seem to be badly hurt, but about a month later he became seriously ill, his heart failed and he died in Khartoum on March 23. By his death the Sudan lost an administrator of great ability and many people a friend whose place they can never fill.

Born in 1894, the youngest of a family of eleven children, he went from Uppingham which he had entered as a scholar to Oriel, again as a scholar, just before the 1914–18 war. In 1914 he joined the West Kent Yeomanry and in 1915 was given a commission in the Dorset Yeomanry with whom he served for three years in the Middle East, first in the fighting against the Senussi in the Western Desert and later against the Turks in Palestine where he was wounded in 1917. In 1920 he was appointed to the Sudan Political Service and in that country he served for the next twenty-five years.

His first station in the Sudan was at Sodiri in Kordofan, the administrative centre of the Kababish nomads. There, and perhaps earlier in the Senussi campaign, he first felt the attraction of the Libyan Desert, to the exploration of which he made a notable contribution. The first of these explorations was in 1923 when, alone save for his Kababish guides, he made a camel journey of 1000 miles from Sodiri to El 'Atrun, last visited by a European in 1908. He brought back a good collection of antiquities—neolithic pottery and implements; discovered and recorded the rock-drawings at Zolat el Hammad and Qelti Umm Tasawir; and, of more geographical importance, mapped the 60-mile long hill feature of Jebel Tageru, before this only a vague name on the map.

In 1927 I had the enjoyment of being his companion in his second Libyan expedition, a camel journey which started from El Obeid in Kordofan and ended two months later at Wadi Halfa on the Nile. We were the first to reach Nukheila (Merga) from the Sudan, though in 1925 Prince Kemal ed Din and Dr. John Ball forestalled our plans to be the first to visit the oasis. From Nukheila a ten-day journey across unknown desert in a vain search for the legendary Zerzura brought us to Selima. Newbold had a flair for route surveying and on this journey the compass and latitude traverse, carried through 2000 miles, was entirely his work. An important result was the discovery that Selima Oasis (last fixed by Browne in 1793 with observations of the occultations of Jupiter's satellites) was shown on the maps 9 miles from its true position, a siting confirmed by W/T observations during Major Bagnold's expedition of 1930 of which Newbold was a member.

Growing responsibilities in the Sudan gave Newbold no further opportunities

for exploration. From 1926 to 1933 he was in Kassala Province, first as District Commissioner at Sinkat where he had the task of introducing a system of native administration among the Beja tribes of the Red Sea Hills and later as Deputy Governor of the Province. In 1933 he became Governor of Kordofan Province and was Deputy Civil Secretary from 1938 to 1939. A few days before the outbreak of war he was appointed Civil Secretary and for the next five and a half years carried on his shoulders much of the responsibility for the Sudan's part in the war, an immense task which ranged over every aspect of the country's life.

In 1919 he became a Fellow of this Society and wrote, with a clear and scholarly style, a number of articles for this and other journals, mostly on the history and archaeology of the Libyan Desert and the Sudan. He often spoke of a wish to write more in the leisure of retirement and what he did write showed that he would have succeeded as well in this as in other things he did. Deserts seem to breed good prose and his account of his 1923 journey, in a little-known journal, *Sudan Notes and Records*, is a model of its kind. In an age when letter-writing is a lost art his private letters were a rare delight.

He was made an O.B.E. in 1933, a C.B.E. in 1938, and a K.B.E. in 1944, and in 1935 received the Egyptian Order of the Nile.

Such were the achievements of a full and useful life and by them he will be remembered in the records of this Society and in the Sudan. But his friends will remember him for other things—for the sympathy and understanding which gave him that genius for friendship of which the Governor-General of the Sudan wrote in *The Times* after his death and which made him that rare being—an unbureaucratic official; for his love of children and English villages and gardens and all the simple things that made England for him, and for others, the best country in the world to come back to. Douglas Newbold was the common man grown great, with a humility and honesty of mind which enabled him to see the needs of the common man, whatever the colour of his skin, and with greatness to advance his well-being by every means within his power.

W. B. K. S.

MEETINGS: SESSION 1944–45

Ninth Meeting, 5 February 1945. The President in the Chair

Geographical Films: The Pacific Theatre of Operations. Commentary by Mr. William Courtenay

Tenth Meeting, 12 February 1945. The President in the Chair

Elections: Clarence Bullock; Rev. Wilfred Charles Couch; George Middleton Cowan, M.C.; George F. Deasy, M.A.; Douglas Alec Dilworth, B.SC.; William Gerald Dunn; Herbert Fenton; Professor Walter Fitzgerald; Douglas Guthrie, M.D., F.R.C.S.E., F.R.S.E.; Miss Mairin Mitchell; Lieut. Richard Arthur Morris, R.E.; Lindley Searle; Ethelred Jean Straker; David Nicholas Strang; Squadron-Leader William J. Swift, R.A.F.; Captain Henry Alexander Sholto West, R.C.E.; Lieut. the Rev. W. Wyeth Willard; Lieut. Leonard Seltzer Wilson, U.S.N.R.; Sir Leonard Woolley, M.A., D.LITT., LL.D.

Paper: The people and country of Ethiopia. (With Kodachrome film.) By Mr. C. Hope Gill

Eleventh Meeting, 26 February 1945. The President in the Chair

Paper: The geographical history of the North Sea and the Strait of Dover. By Dr. L. Dudley Stamp

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